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POWER AND THE ENGINEER

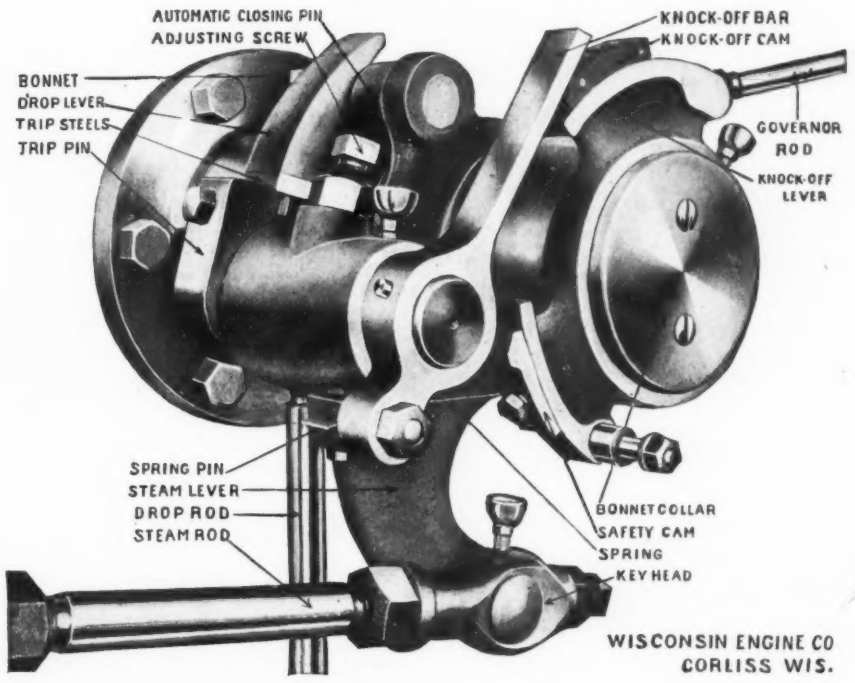
ISSUED WEEKLY BY THE HILL PUBLISHING COMPANY, 505 PEARL STREET, NEW YORK.

Vol 29. Index to Advertisers and Classified Index Following Reading Matter No. 13.

WISCONSIN ENGINE COMPANY

CORLISS, WISCONSIN

"Higher Speed" Corliss Engines—High Duty Pumping Engines—"Complete Expansion" Gas Engines



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MEANS FURNACE EFFICIENCY AND ECONOMY.

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You can't consider the matter of drafts, of fuel, of methods of firing, without taking "excess air" into account.

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furnishes the means to accomplish this object. It is a simple, reliable, inexpensive apparatus that determines Oxygen, Carbon Monoxide as well as Carbon Dioxide. It points out why you are not getting all the energy out of your fuel. It is portable. A boy can understand and operate it.

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is a companion of the Gas Analysis Instrument. It stores the flue gases for any given period. One analysis of gas from the vessel gives you the exact average for the given period.

The Hays Gas Analysis Instrument.

With these two instruments you can start building up your furnace efficiency. The results will be immediate and positive. You can accomplish more with these two instruments than you can with the delicate and expensive automatic recording CO_2 machines now on the market.

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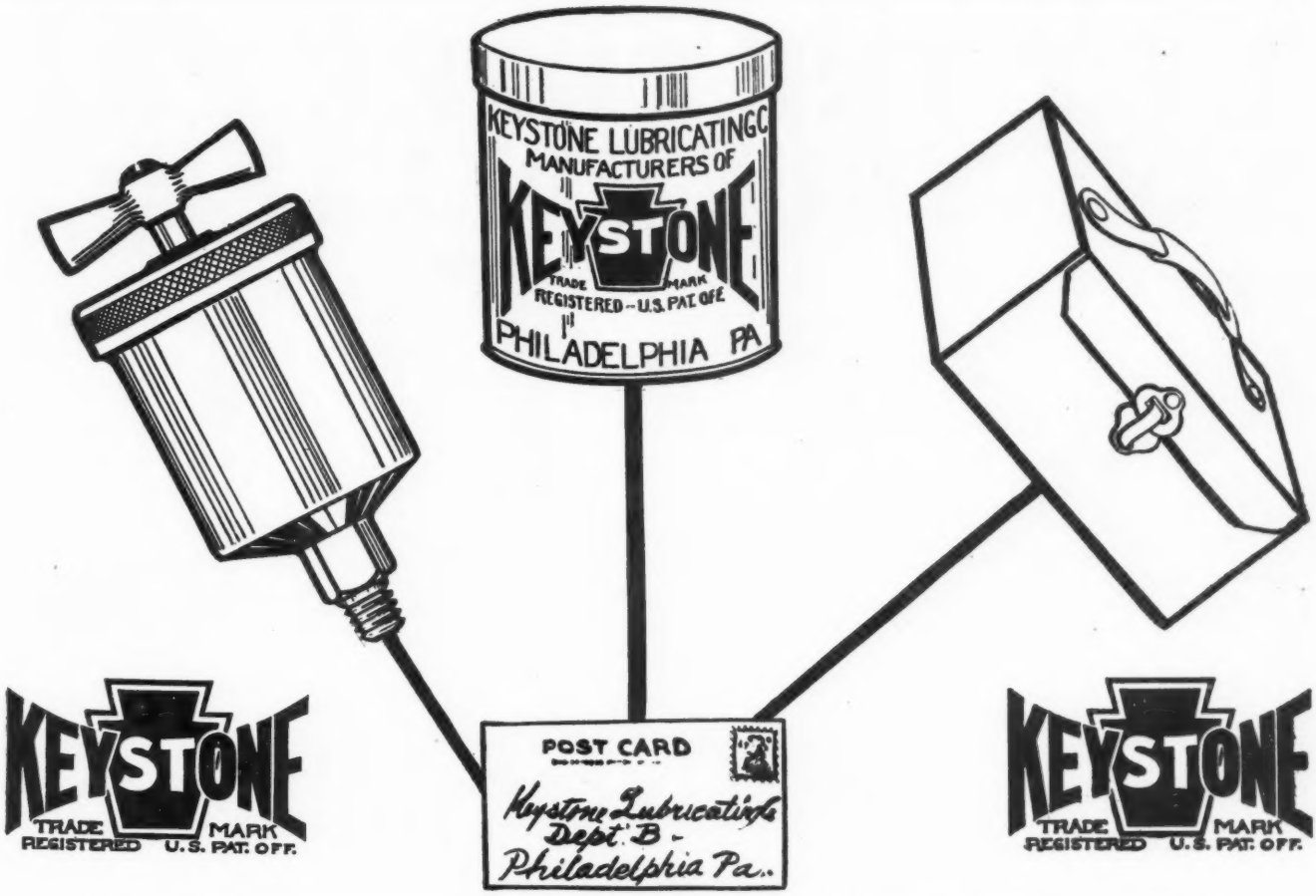

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Name . . . . . *Address* . . . . .
Name of Firm . . . . . *H. P. of Engine* . . . . .
On what bearing will sample be tested . . . . . *Its width* . . . . .
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Sept. 29, '08.

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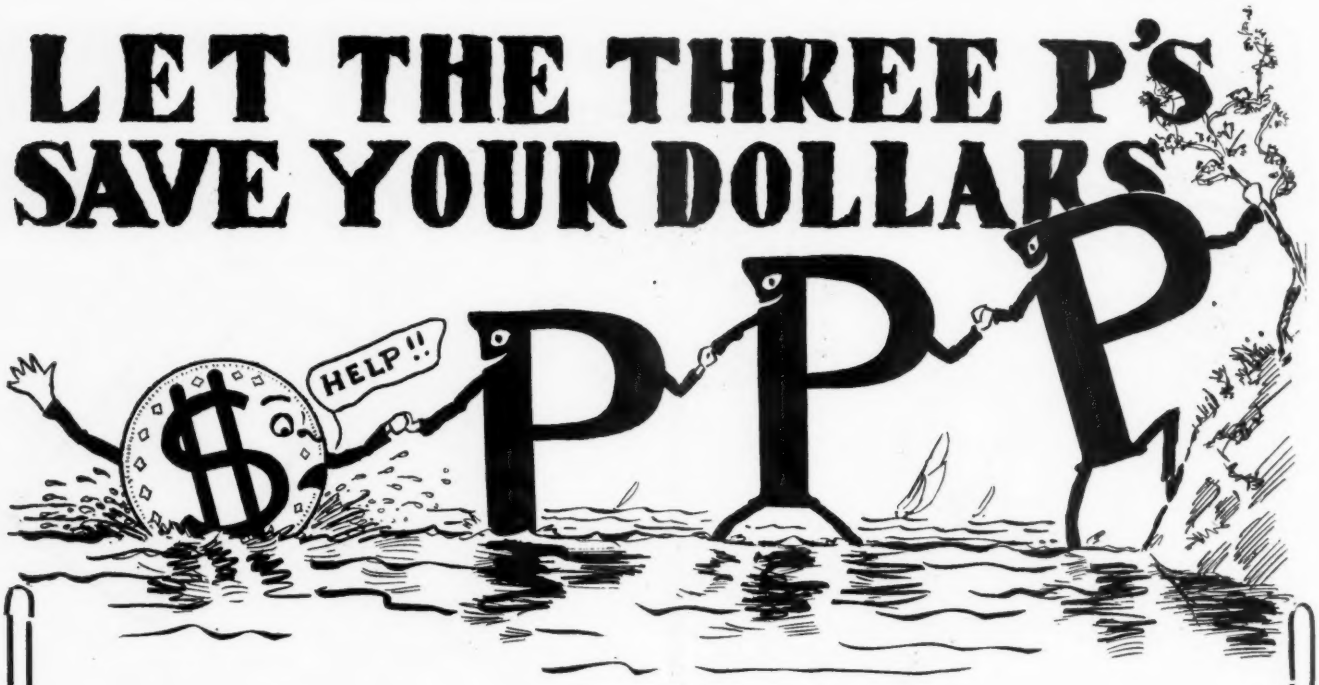

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Daniel's P. P. P. Packing is a great dollar saver—time and labor saver, too! Just pack your engine with Daniel's P. P. P. and when the time comes to repack, as you would with other packings, you'll find that it isn't necessary. Right there your wisdom in using P. P. P. Packing saves the cost of extra packing—and the bother of packing it also. Pleasant surprise indeed! And you have many such surprises before P. P. P. wears out. Even then, it's simple work—just add an extra ring, screw up the gland with your fingers and forget it.

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Write for illustrated P. P. P. Booklet.

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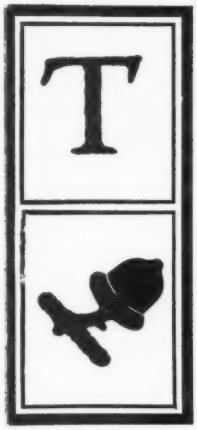
The House of Dearborn



THERE is always one great pioneer and leader in the development of every important industry. Twenty years ago, the fact that great savings could be made in fuel consumption and that boilers and boiler tubes could be made to last much longer, but for the detrimental action of boiler feed waters, interested some young chemists in Chicago in the possibility of surmounting this difficulty by making careful analytical study of different classes of waters, and finding scientific reagents for the elements that produced the trouble.

Thus began the work of the DEARBORN COMPANY. That it has been successful is attested by the fact that thousands of steam plants use their products, prepared according to analysis of the waters, and find absolute relief from the troubles formerly experienced.

With its large corps of representatives, all of whom are *mechanical experts*, working in all sections of the country, backed by the scientific laboratory work done at Chicago, the Dearborn Company is able to give personal attention to every case, making careful study of the water and plant conditions and furnishing treatment that exactly meets requirements.

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Every engineer has experienced those annoying pipe line leaks, especially in screw joints where it is impossible to shut down in order to fix things up.

The day is over for worry, however; pipe line leaks can now be stopped without shutting down and with little trouble and at small expense. No elaborate apparatus is required, only two simple articles, SMOOTH-ON TAPE AND SMOOTH-ON ELASTIC CEMENT.

Here is the way to do it: Wrap the joint with one layer of SMOOTH-ON TAPE (this tape is especially prepared and is very adhesive), give the tape a thin coating of SMOOTH-ON ELASTIC CEMENT, then another wrap of tape and coating of cement. Repeat this operation several times and you will have a perfect and permanent joint. Simple, isn't it? But best of all the joint will never leak again.

Here's what one man says about it:

Adrian, Wis., Nov. 23d, '07.

"Gentlemen—

"The Smooth-On Compound and Elastic Cement came to hand all right and it gives me great pleasure to say that I was entirely successful in stopping the leak in my main line steam pipe mentioned in my first letter. Although it was a very bad one, being a screw thread joint, it is stopped as completely as though it had never been.

"The proprietors as well as myself are very much pleased with the result obtained. It is certainly a boon to engineers as well as a great saver of time and money to owners of steam plants, and should find its way into every engine room in the land."

Very respectfully yours,

J. D. Bingham,
153 E. Maumee Street.

SMOOTH-ON ELASTIC CEMENT can be used for a number of places where it is as useful and permanent as on screw joints, and may be applied as a paint, paste or putty.

Sold in 1, 5 and 10 pound gray labeled tin cans.

Don't forget we make SMOOTH-ON for all purposes for use around the power plant—there is hardly a repair where SMOOTH-ON cannot be used to advantage.

SMOOTH-ON GASKETS for flange joints are without an equal. Send for Smooth-On instruction book No. 5—it contains a lot of interesting points for any engineer.

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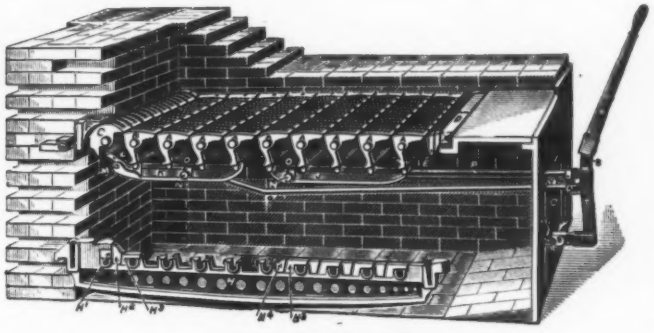
No Waste Of Unconsumed Fuel

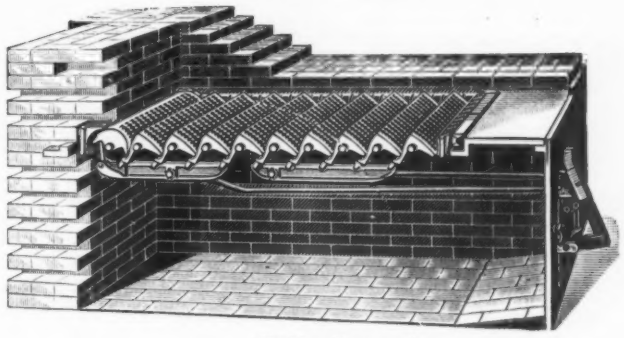


Normal Position of Grate

The fire surface is especially adapted to prevent the waste of fine fuel such as slack, screenings, duff, etc.

The shaking movement does not increase the size of the openings.

Experts pronounce the

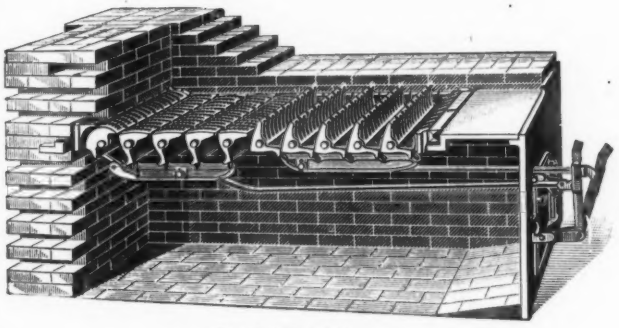


Shaking Movement

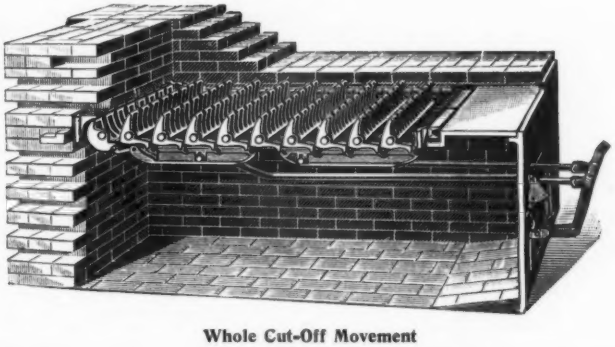
McClave Grate and

Argand Steam Blower

Argand Blower



Divided Cut-Off



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combination superior to any other system of fuel burning ever devised and back their judgement with their orders.

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Scranton, Pa.

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Do Not Be Influenced.

Look Into The Merits of

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And We Know What Your Decision Will Be.

WE CLAIM THAT our 24 years' experience has enabled us to give engineers the most economical boiler feeder. We mean---**STEAM ECONOMY.** A few dollars saved in the cost of a good Injector cuts no figure. The saving in steam, which means fuel, will save the difference many times. With care they will last as long as the boiler, and that's long enough. Our construction is such that no pet-cock to drain Injector is necessary, always leaking and a source of annoyance. Can always supply one if wanted. **BUT YOU DO NOT WANT IT.**

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IT WILL LIFT 25 FEET OR LIFT 1 FOOT AND ELEVATE 125 FEET.

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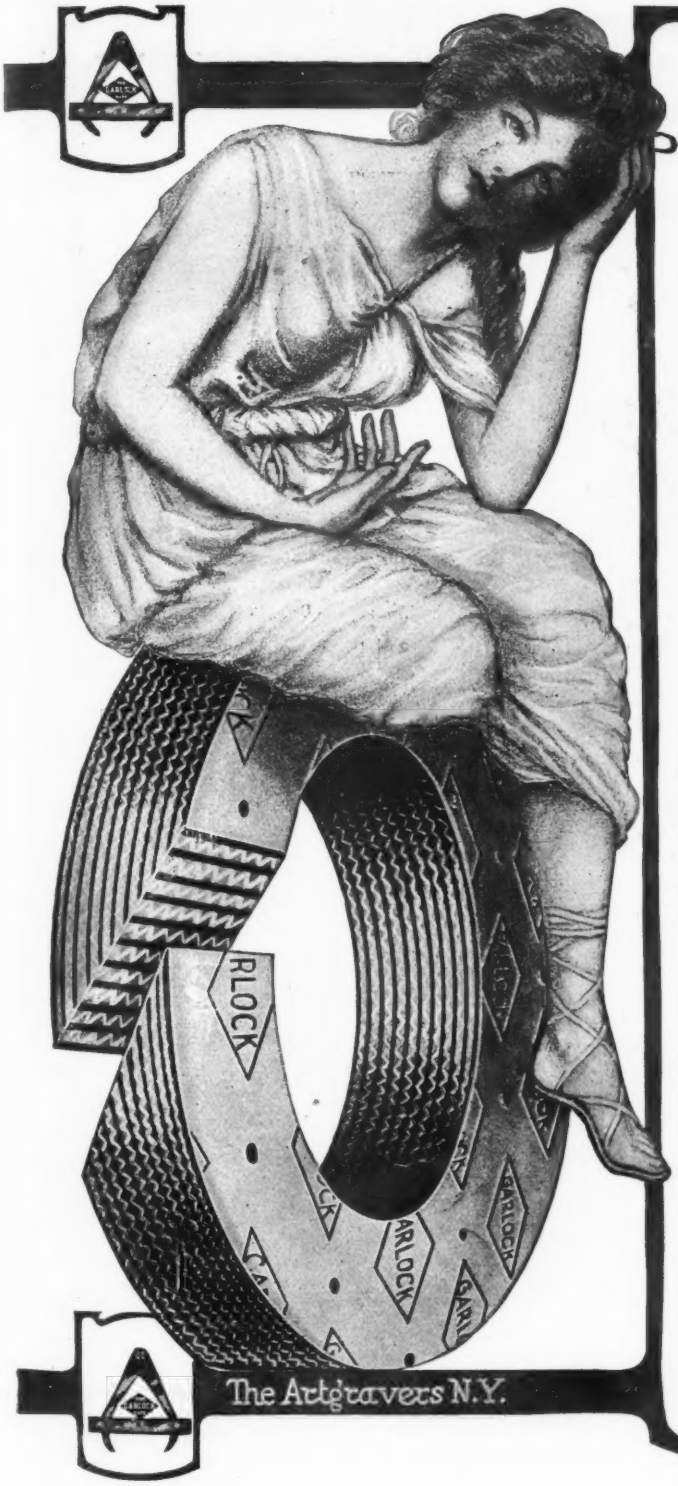

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Another "Burt" Unit Filter For The Kodak People

Read What They Have To Say:

EASTMAN KODAK COMPANY
Rochester, N. Y.

The Burt Mfg. Co., Akron, O. June 17, 1908.

Gentlemen—Replying to yours of the 12th inst., would say we have installed a second of your latest improved "Unit Type" oil filters. The results obtained in the operation of an engine by having a continuous stream of pure oil delivered to the bearings is far superior to the old scheme of lubrication from oil cups. We are, therefore, very well pleased with the unit filter system and are convinced that the same will result in considerable saving, not only in the oil but in the life of the engines.

Yours truly,
Eastman Kodak Company,
P. E. Wilcox, Ass't Mgr. Kodak Park Works.

Send for our 96-page Catalog.

THE BURT MFG. CO., 232 Main St., Akron, O., U.S.A.

Largest Manufacturers of Oil Filters in the World.

New Power Plant of the Pennsylvania R. R.

Salient Features of the Recently Completed Power House Installation at Ashtabula Harbor, Ohio, with Especial Reference to the Storage Battery

BY WARREN O. ROGERS

The storage battery with an automatically regulated booster provide a most satisfactory method of balancing load fluctuation where the demand upon the generators is greater than can be taken care of otherwise. The application of storage batteries to assist in close load regulation is open to all fields and demands, including not only street-railway and lighting plants, but the isolated station as well. An example of such application is that of the new power house of the Pennsylvania Railroad Company, at the river docks, Ashtabula Harbor, O.

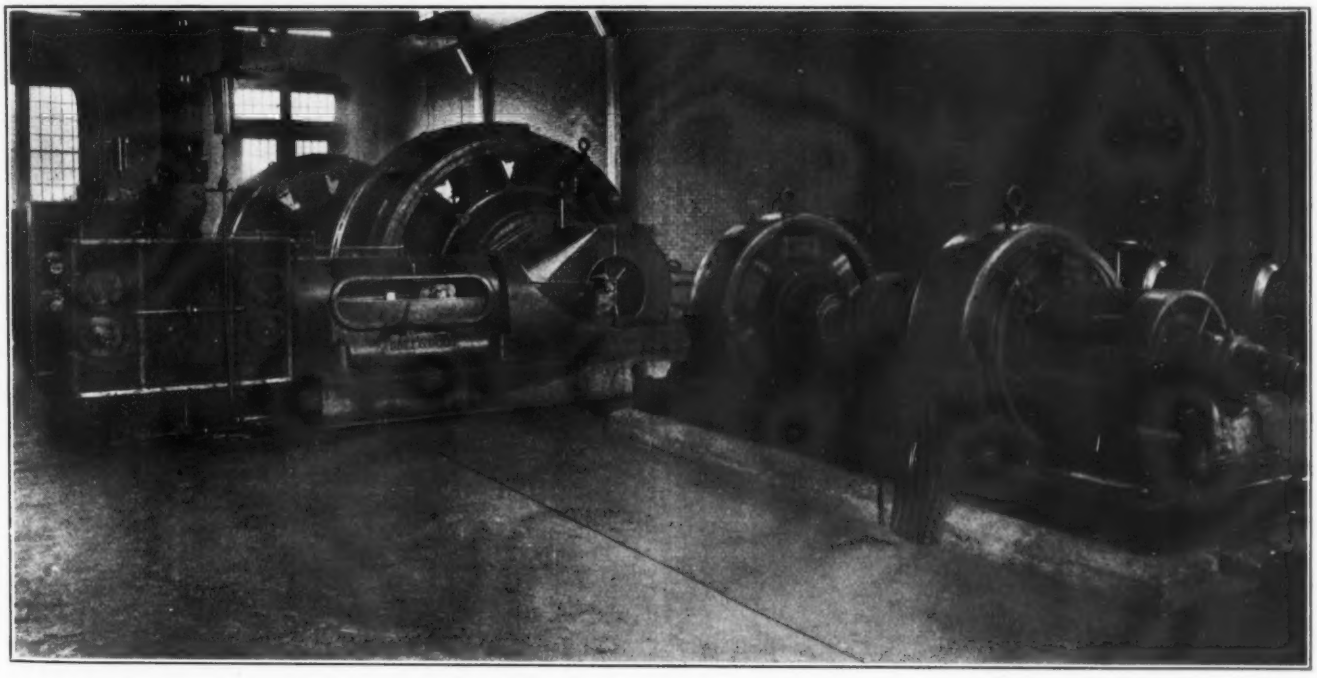


FIG. 1. VIEW IN THE GENERATING ROOM

The plant was built with the sole purpose of electrically operating six man-trolley, six-ton ore unloaders and one bridge conveyer, carrying the ore from the steamers at the docks to the ore-storage pile.

Engines and Boilers

The present building, which is a steel structure, bricked in, was designed with the view of installing three 400-kilowatt generators and six 200-horsepower water-tube boilers. At present the plant comprises four 200-horsepower water-tube boilers of the Stirling type and two Ball & Wood 20x32x27-inch cross-compound four-valve condensing engines. To these engines are direct-connected two 400-kilowatt Fort Wayne direct-current generators, flat compound wound, the voltage varying from 230 to 240 at the switchboard. Fig. 1 shows the engine room and the booster set.

The four 200-horsepower boilers are equipped with Roney stokers and set in batteries of two each. A coal hopper suspended over each stoker is capable of holding 40,000 pounds of coal. The coal is delivered to a hopper outside of the boiler building, being received in cars and dropped into a 15x15-foot track hopper made of ¼-inch steel plate. The coal can be fed at the rate of 40 tons per hour to a 24x24-inch two-roll coal crusher, which reduces the coal to 1½-inch cubes.

From the crusher the coal drops to a 24-inch close-contact pivot bucket, which runs at the rate of 50 feet per minute. A traveling dump on the upper run distributes the coal to the four circular coal bunkers located over each stoker and delivers it to each by means of chutes, the flow being governed by means of rack-and-pinion gates. The ash is raked from the ashpit into the lower run of the conveyer and carried to a chute over the track hopper and delivered directly to cars standing on the track. The bucket conveyer is operated by means of a 10-horsepower direct-current motor, while the crusher is operated by a 25-horsepower direct-current motor.

Feed Pumps

The boilers are fed by means of two outside-packed plunger pumps having 10x6x12-inch cylinders. The feed water is taken through a manifold which allows the feed pumps to pump either directly from the intake well, the hotwell, or from a future city water supply. The feed water is pumped through a closed heater and enters the boilers at a temperature of about 210 degrees Fahrenheit. The supply of steam for the inclosed heater is obtained from the exhaust from the auxiliaries, which consist of a turbine pump, two boiler-feed pumps, the stoker engines and vacuum pumps, all of which operate non-condensing. Fig. 2 shows the boiler-room installation, including the auxiliar-

ies; also the base of the concrete chimney, 150 feet high and 7 feet 6 inches in diameter, of sufficient size to take care of twice the present boiler capacity. The boiler room is fitted with a complete layout of lattice-iron platforms and ladders which allow of easy accessibility of doors for cleaning the boilers and operation of the valves on the pipes and headers. A steel breeching conveys the escaping gas to the chimney.

Piping

The piping is arranged on the unit system, so that any one boiler can be used for supplying the auxiliary or any of the steam units. The stack and auxiliaries are designed to permit the addition of a fourth unit, an ultimate capacity of eight 400-horsepower boilers. Fig. 3 is a plan view of the plant, while Fig. 4 shows an elevation of the boiler and engine rooms.

Condenser Equipment

The condenser equipment consists of a Hessler barometric condenser of sufficient size to take care of three units. The circulating water is handled by a centrifugal pump driven by a noncondensing steam turbine. The condenser is also provided with an air pump for priming the circulating pump, and also to take care of the air leakage of the piston packing and exhaust piping. The water for the condensing pumps flows by gravity through a 24-inch pipe from the river into a two-part intake well. The barometric tube and also the traps discharge into a hotwell from which the boiler feed is taken, but from separate parts of the hotwell, which is divided by a steel partition, the water being taken from the center of the well to avoid getting oil and sediment. The discharge is returned to the river through a 24-inch discharge pipe.

The Unloaders

The load which the plant carries consists of "unloaders." An unloader is a movable structure with cantilever arms extending out over the boats. Upon these arms a trolley is arranged from which is suspended, by means of drums, a 6-ton bucket, the operator's cage being a part of the trolley. The ore is picked up out of the steamer and dropped either into a weighing hopper, and from the hopper into cars, or into a trough back of the unloaders, from which point the bridge picks up the ore and deposits it in the ore storage, which has a capacity of 880,000 tons. The bridge is 550 feet long, has a transverse movement of 800 feet and is equipped with a 14-ton clam-shell bucket.

The hoist motors on the bridge are four 110-horsepower series machines. The trolley is operated along the bridge by four 35-horsepower motors of the railway type, and the transverse movement of the unloader is produced by one 35-horsepower railway-type motor; there is also a 50-horsepower railway-type motor for hoisting the boom, making a total of 2970 horsepower. Besides this, there are a number of smaller motors for operating the gates of the weighing hoppers, the air compressors on the machines and the bridge for operating the brakes.

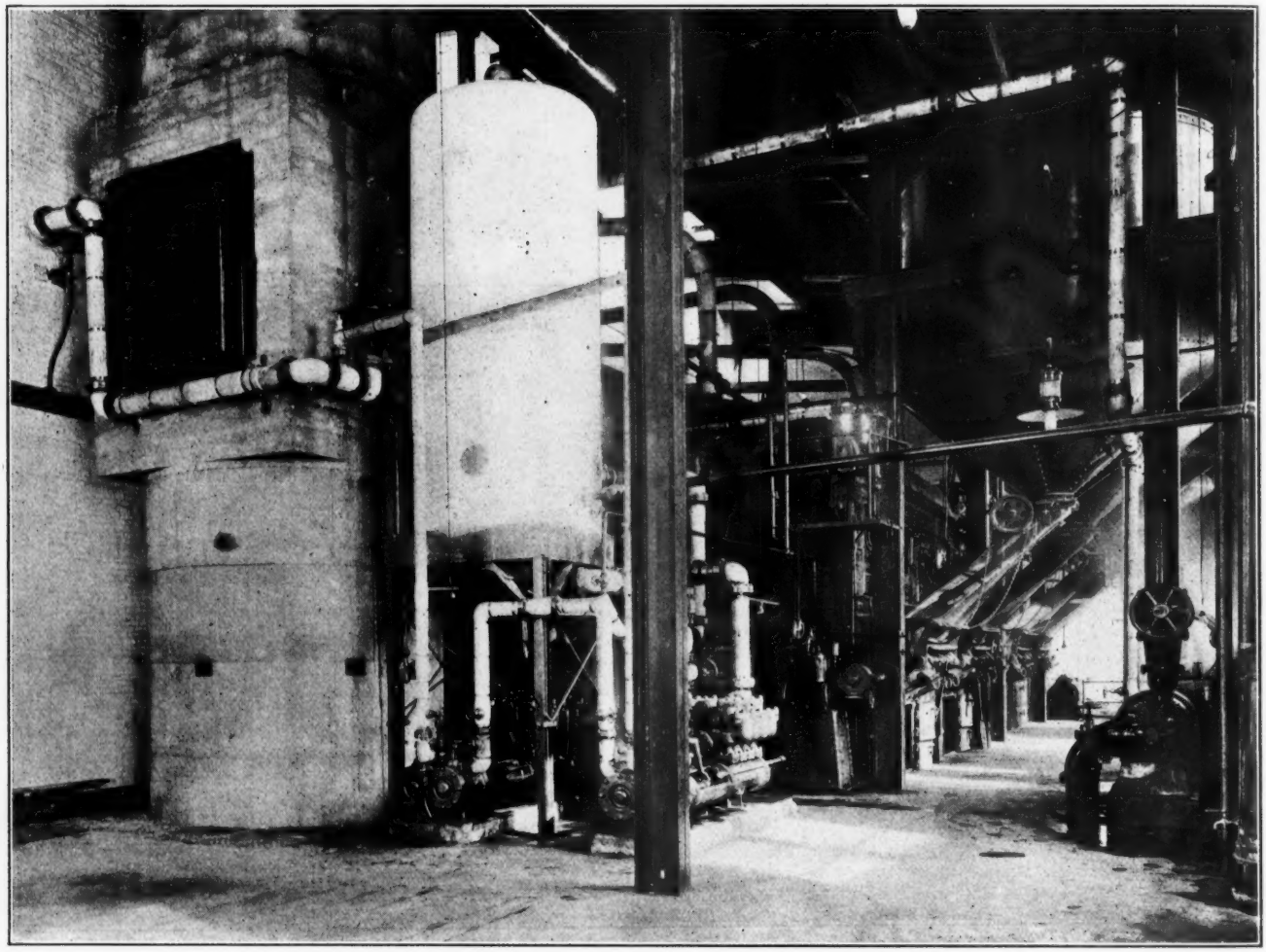


FIG. 2. BOILER ROOM; AUXILIARIES IN THE LEFT FOREGROUND

For the proper operation of this equipment, it was decided that direct current would be better for handling the required service, and a normal voltage of 220 was determined upon, as against 500 volts, on account of the less liability of loss of life due to carelessness of the operators.

Maximum Load

When hoisting ore, the bridge and traversing trolley are subject to a maximum current of 2800 amperes. The unloaders at maximum load are each subject to a current of 1400 amperes, or a

total of 11,200 amperes. This load is augmented at night by about 150 amperes, making a total maximum load of 11,350 amperes; but up to date the maximum peak load has never exceeded 8000 amperes; in service it repeatedly runs as high as 7000 amperes. The maximum load in the power plant amounts to 1920 kilowatts, while the average load through the day is approximately 400 kilowatts, the load in amperes varying from 0 to 8000 amperes. In order to handle this service satisfactorily, storage batteries were installed.

Storage Batteries

The storage-battery installation consists of 110 cells of 35 plates each of the Gould U-type battery in 53 plate tanks, which allows of a 50 per cent. increase in the number of plates. The batteries are installed in a one-story building adjoining the engine room, as shown in Fig. 5. In order to prevent any deterioration of the plates from iron-ore dust, the windows are made air-tight and the battery room ventilated by forced draft, a fan exhauster taking air from the basement and forcing it through radiators in the floor along both sides of the battery room. The air is expelled through four ventilators in the center of the roof. This exhauster is also provided with heating coils

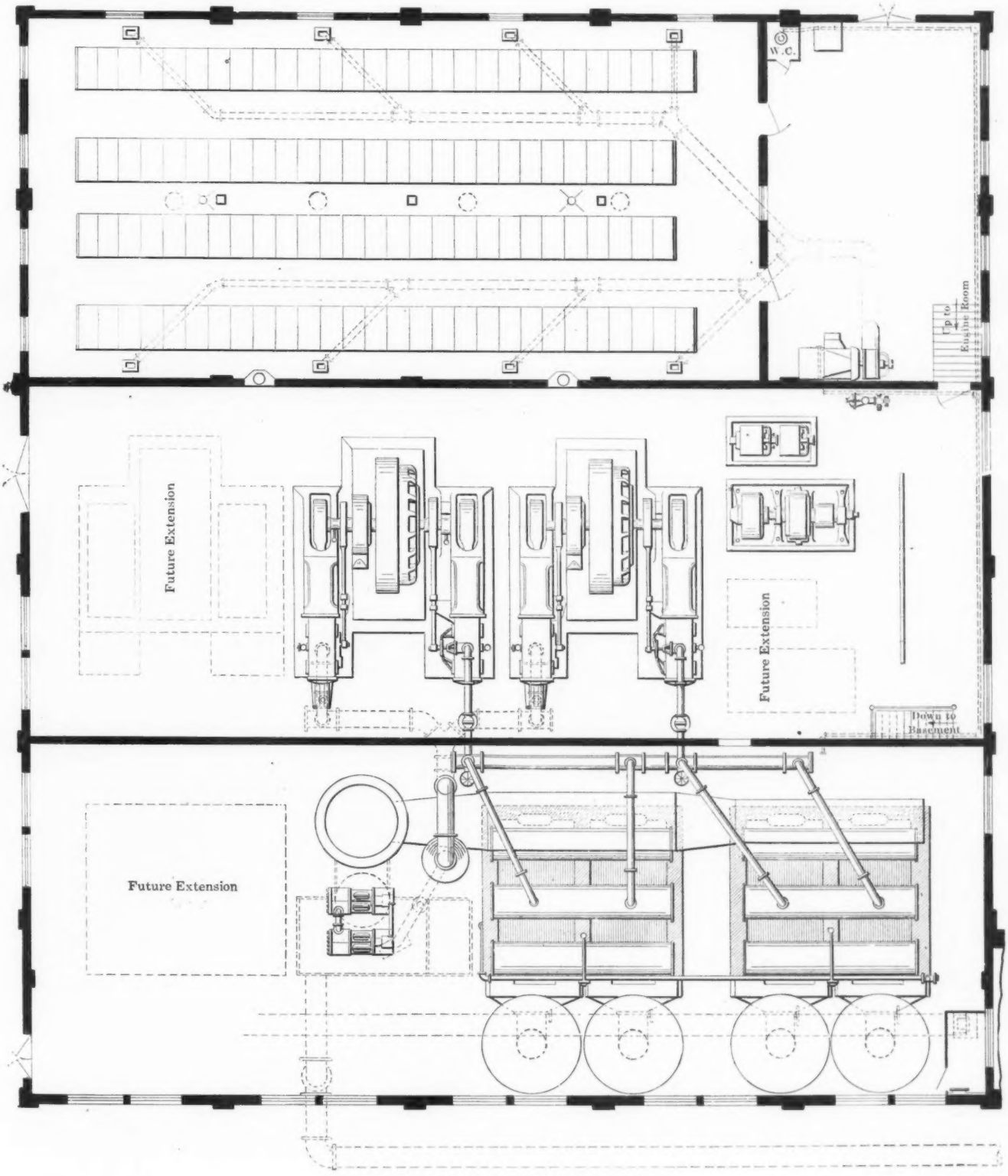


FIG. 3. PLAN OF THE COMPLETE PLANT

to keep the battery room at the proper temperature during the winter.

The battery-room floor consists of a concrete foundation covered with vitrified brick laid in pitch, upon which are placed sulphur pieces finished on top with red vitrified tile, about 6 inches square, with long glass-petticoat insulators resting upon the tile supporting the stringers, which are subdivided at every sixth cell in order to insure perfect insulation. Each individual cell is supported and insulated from the stringers by a second tier of glass-petticoat insulators and the tanks spaced from each other by means of heavy, glass blocking pieces, which not only hold the cell rigidly in place, but prevent any bulging of the sides.

The complete battery control was installed by the Gould Storage Battery Company, and so arranged that one 400-kilowatt generator will handle the complete load of the plant and will operate practically at constant load. Under ordinary conditions the machines operate at 2000 amperes, but at heavy overload the batteries, through the booster, will allow the generators to pick up the excess load, up to the setting of the circuit-breaker of 3500 amperes. The limiting device also works in an opposite direction and prevents a heavy charging rate to the battery in case of "no load" condition.

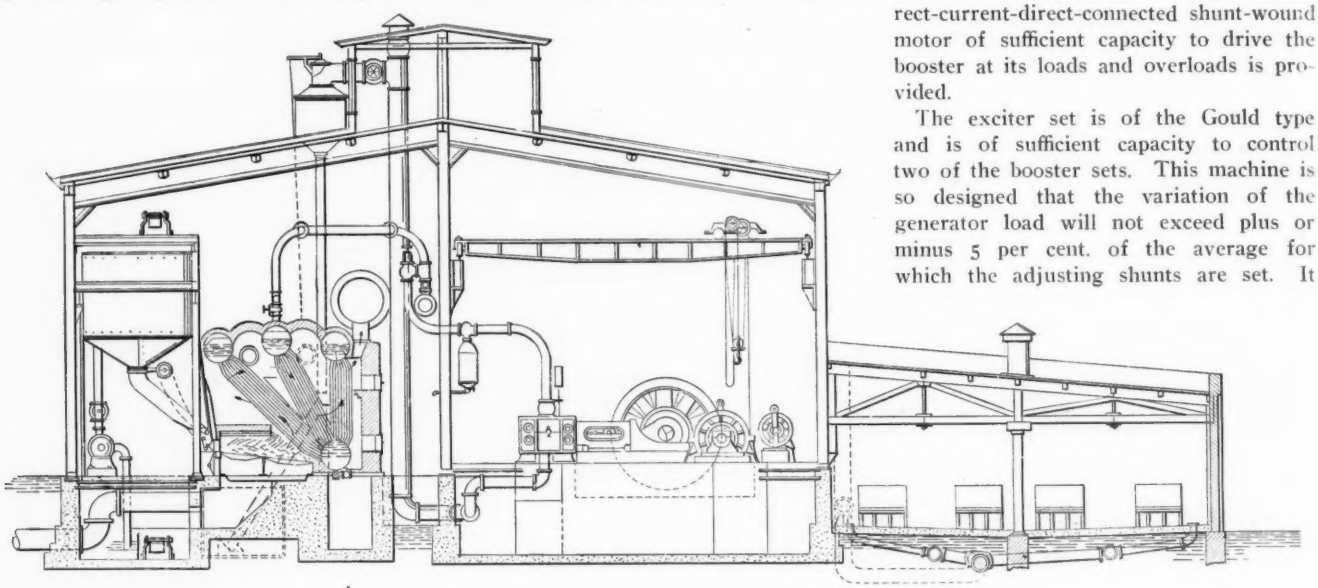


FIG. 4. SECTIONAL ELEVATION OF COMPLETE PLANT

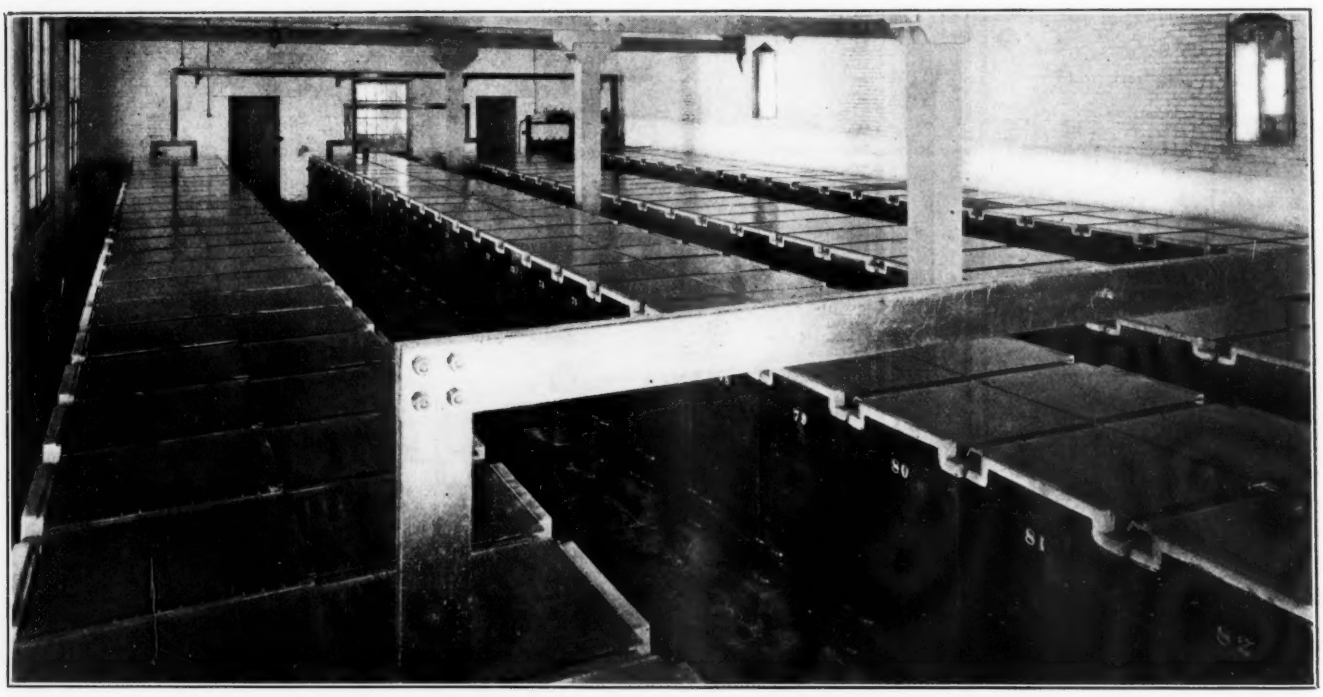


FIG. 5. VIEW IN THE STORAGE BATTERY ROOM

The Booster and Exciter Set

The booster is of the Westinghouse make and is a direct-connected set, consisting of a double commutator mounted on a cast-iron base. The booster has a continued rated capacity of 2400 amperes and an overload capacity of 4800 amperes. The outputs are at any voltage from 0 to 60 in either direction. A 250-volt direct-current-direct-connected shunt-wound motor of sufficient capacity to drive the booster at its loads and overloads is provided.

The exciter set is of the Gould type and is of sufficient capacity to control two of the booster sets. This machine is so designed that the variation of the generator load will not exceed plus or minus 5 per cent. of the average for which the adjusting shunts are set. It will also take care of the instantaneous fluctuation of load, and all magnetic circuits are made with practically zero time element. The load conditions at this plant are extremely severe, as at times the generator or generators will be carrying an average of 1200 amperes or less, while the momentary demands will be in the neighborhood of 6000 amperes or greater. With the booster set described, the battery and booster circuit-breakers would open when the battery discharge exceeded 4800 amperes, and this load instantan-

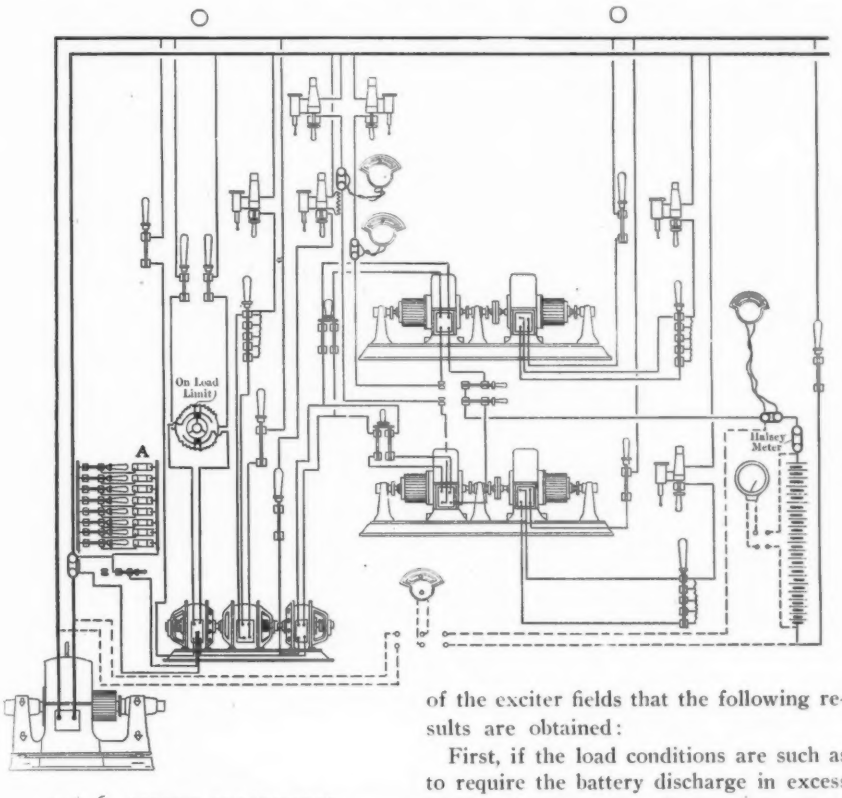


FIG. 6. BOOSTER CONNECTIONS

eously thrown upon the generators would cause an interruption in the service. In order to avoid this condition in operation there is installed an automatic load-limit device, which so modifies the excitation of the exciter fields that the following results are obtained:

First, if the load conditions are such as to require the battery discharge in excess of the 4800 amperes, the generator load is automatically increased so that the battery holds its maximum load and allows the excess of the peak above this to be taken care of by the overload capacity of the generators.

Second, the same action takes place when the battery charge exceeds the predetermined safe limit. In this case the generator load is, of course, reduced.

Third, if the booster voltage tends to exceed the capacity of the machine on either battery charge or discharge, due to the battery taking an overdischarge, or overcharge, the generator load carried is automatically adjusted so that this condition of excess charges or discharges is corrected. These actions are all obtained automatically, and the load-limit device returns to its normal position, leaving the generator load at that for which the adjusting switches are set, as soon as the load conditions have returned to a value permitting the same. The diagram, Fig. 6, shows the connections for two boosters operating in parallel and controlled by one exciter set. At present there is but one booster installed. The switchboard and exciter set are installed for the ultimate capacity of the two machines. Referring to Fig. 6, it will be seen that a set of switches is located at *A*, at the left-hand corner of the drawing. These switches control the adjustment of the generator load by throwing the auxiliary shunts in parallel with the main-line shunt. On the right-hand side of the drawing is shown the shunt for the control of a Halsey recording ammeter, which, however, has not been installed at this writing.

THE SWITCHBOARD

A complete wiring diagram of the plant,

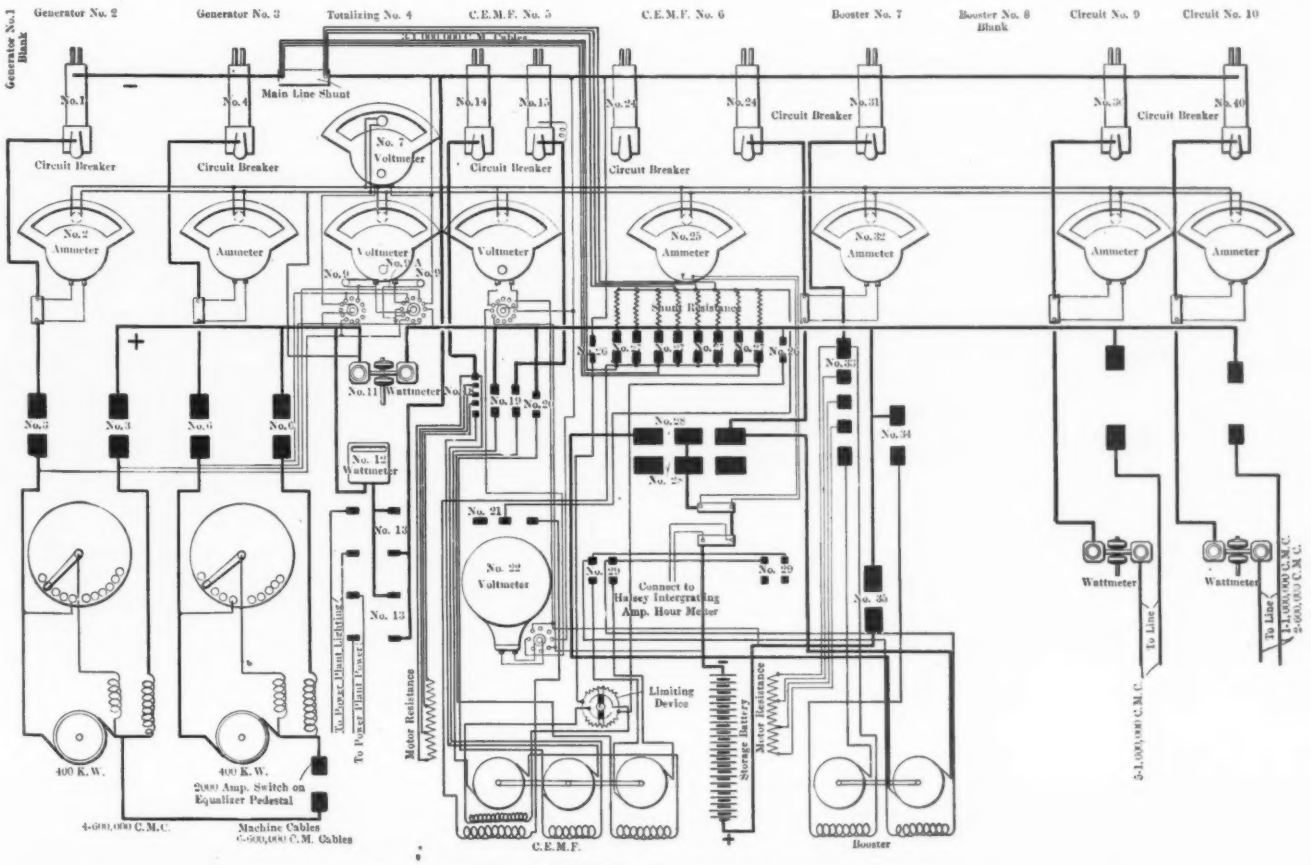


FIG. 7. DIAGRAM OF SWITCHBOARD AND STATION CIRCUITS

including the generators, booster-battery machines and switchboard, is shown in Fig. 7. The switchboard consists of 10 panels divided as follows: Three generator panels, one of which remains blank for the accommodation of the third generating unit when installed; one totalizing panel; two C. E. M. F. panels, and two booster panels, one of which remains blank and two circuit panels. Each panel is equipped with the necessary instruments, switches, etc., as shown in Fig. 8.

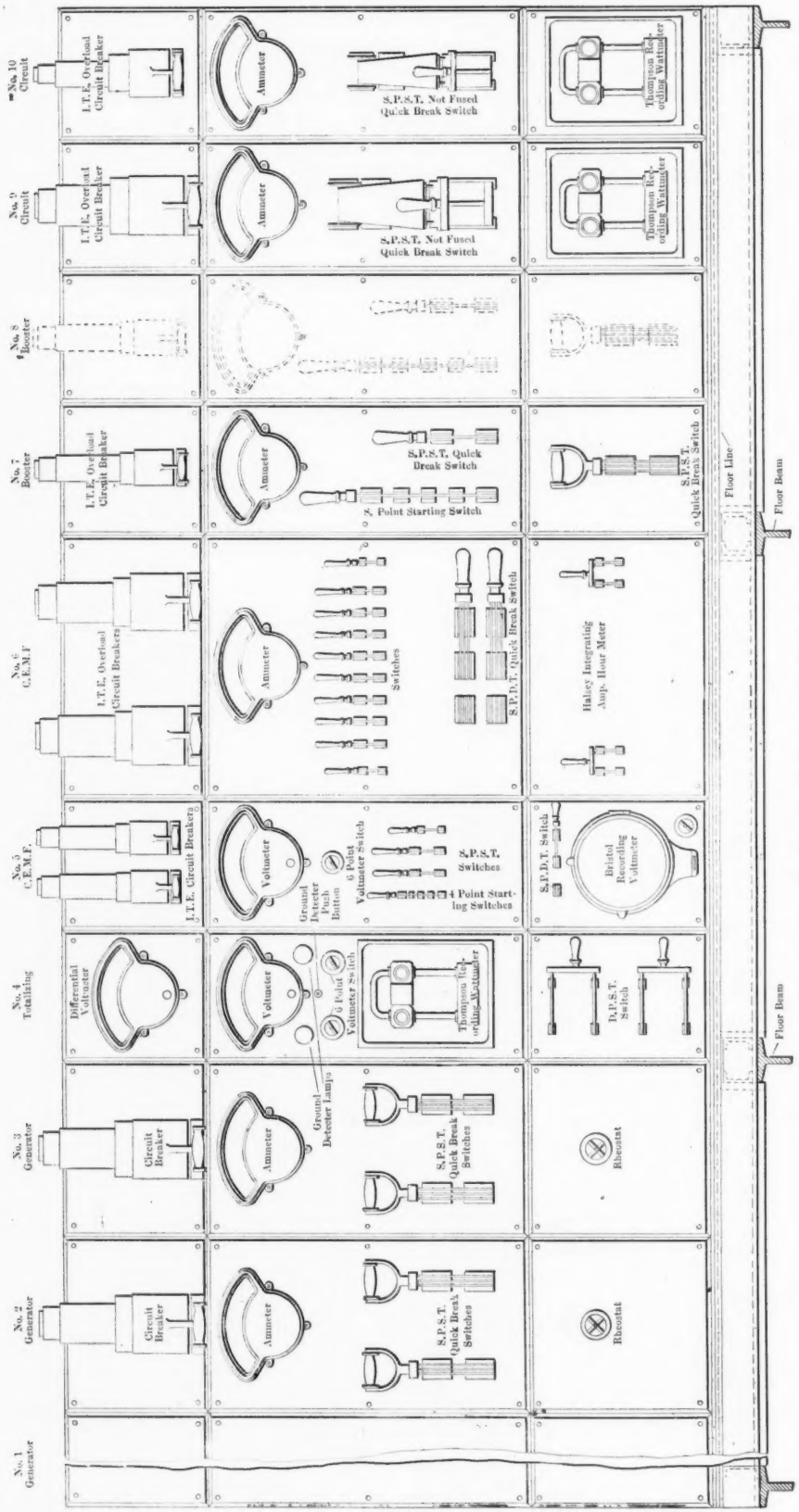


FIG. 8. FRONT OF THE SWITCHBOARD

During the winter the plant, although in commission, does no ore unloading, current being used for loading ore from the ore-storage pile to the cars for shipment, and for illuminating the yard and similar service.

Catechism of Electricity

The Direct-current Motor

763. *What is an electric motor?*

An electric motor is a machine for converting energy in the form of electricity into energy in the form of mechanical motion.

764. *How does this conversion take place?*

Through the force mutually exerted upon each other by two magnetic fields within a small space between the stationary and movable members of the machine.

765. *Does it make any difference how the two magnetic fields are formed?*

Only a difference in degree. The two magnetic fields may be formed by currents flowing in two wires (straight or coiled, with or without cores), or by two permanent magnets, or the one field may be produced by a current in a wire and the other field by a permanent magnet.

766. *Explain how the magnetic fields produce mechanical motion in an electric motor.*

When the lines of force of two magnetic fields meet without coinciding in direction, each set exerts a pull upon the other which tends to draw them into agreement as to their direction in space; this pull is transmitted to the parts in which the magnetic lines of force originate, and will tend to draw them into such a position that the lines of force of the two fields will coincide to the greatest possible extent. The greater the strengths of the magnetic fields, the stronger will be the force thus acting, and if the fields be sufficiently strong, mechanical motion will be given to that part which moves the more readily.

767. *Describe a simple arrangement which illustrates this action.*

Fig. 265 illustrates such an arrangement. One magnetic field is produced between the poles of a horseshoe magnet *M* and the other by a current flowing in the loop of wire suspended between the magnet poles with its plane parallel to the lines of force of the magnet. The lines of magnetic force set up by the current will be projected at right angles to those of the magnet, which are represented by dotted lines, and if the magnet be held so it cannot move and the loop be freely suspended, the latter will turn through 90 degrees to the position in which the lines of force of the magnet's field will thread through it in the same direction as its own lines. If the current through the loop be reversed in direction, the direction of the lines of force formed by it will be reversed, and the loop will tend to turn through 180 degrees or until the

lines of force of both fields again coincide in direction.

768. *How is this practically applied in en electric motor?*

Suppose an armature with one coil connected to a two-bar commutator, as shown in Fig. 266, be placed in a magnetic field between the poles N and S. If brushes be pressed against the commutator, as indicated in the sketch, and a current be sent through the coil in the direction indicated by the small arrowheads, this current will set up a magnetic field in the armature core a and the surrounding air, and the lines of magnetic force will have the direction of the arrow A through the core. The lines of force set up by the magnet have the direction shown by the arrows near the letters N and S, and the magnetic pull between these two fields will turn the armature over in the clockwise direction until the arrow A is parallel with the arrows on the magnet poles, as shown by Fig. 267. When this position is reached, the pull between the two magnetic fields ceases, because their lines of force coincide, and the armature would come to a stop in this position but for the commutator.

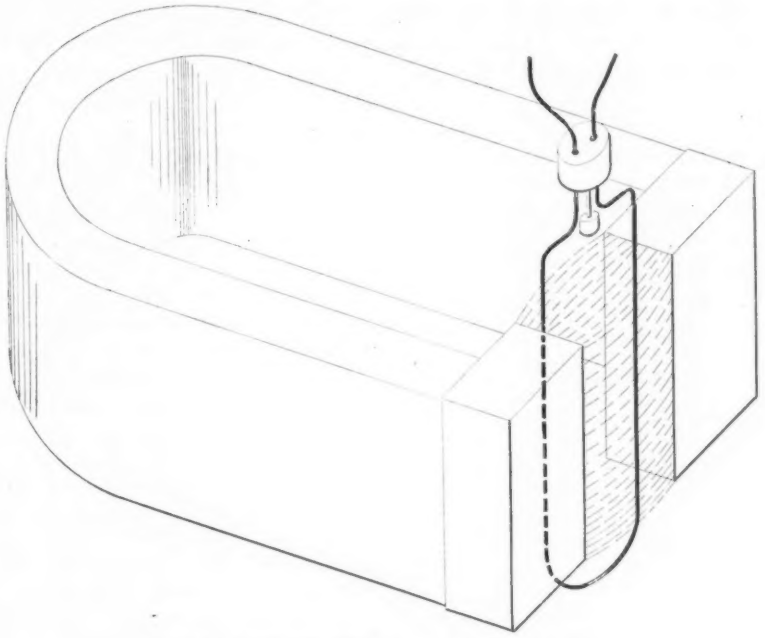


FIG. 265. LOOP CONDUCTOR IN A MAGNETIC FIELD

769. *How does the commutator keep the armature revolving?*

When the armature reaches the position shown in Fig. 267, its momentum carries it slightly past, so that the positive brush touches the half *1* of the commutator and the negative brush touches the half *2*; this reverses the current through the coil and the magnetic field set up by it is also reversed. Consequently, instead of agreeing with the main field set up by the magnet, the armature field is in opposition to it and the two react to pull the armature around one-half a revolution, to the position opposite that in Fig. 267. When the momentum of the armature carries it past this position, the brushes and commutator again reverse the direction of the current in the armature coil, and the armature is kept revolving.

770. *Has a motor armature only one coil?*

No; it has a number of coils, connected up to a commutator with a number of divisions, and as each coil passes the position midway between the magnet poles, the current flowing through it is reversed, as described for the single coil.

771. *What determines the speed of rotation of the armature of a motor?*

The counter electromotive force developed in the coils of the armature.

772. *What is the counter electromotive force?*

It is the electromotive force induced in the armature conductors by cutting the lines of force of the field set up by the magnet, as in a dynamo.

773. *What determines the strength of the counter electromotive force of a motor armature?*

The speed or rapidity with which the armature conductors cut across the magnetic field, the strength of that field and the number of conductors connected in series in the armature winding.

774. *What is the direction of the counter electromotive force with respect to the armature current?*

The counter electromotive force induced in each conductor by its motion through the main magnetic field is always in opposition to the current in the conductor which produces that motion.

775. *How does the counter electromotive force affect the speed of rotation of an armature?*

It tends to stop the motion of the armature because it opposes and decreases the current which is flowing through the coils of the armature, and the motion of the armature due to that current varies in vigor with the strength of the current.

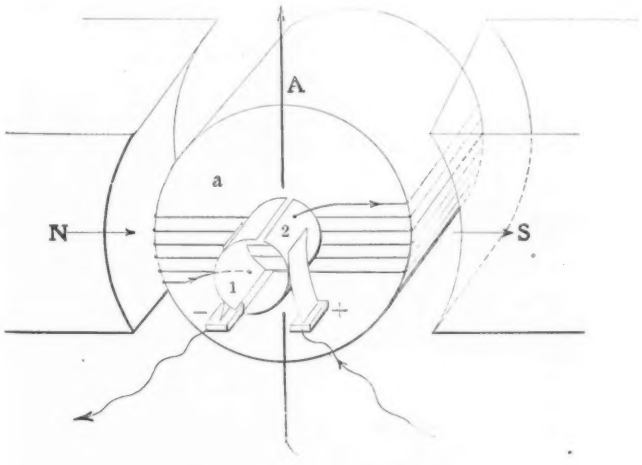


FIG. 266. POSITION OF MAXIMUM PULL

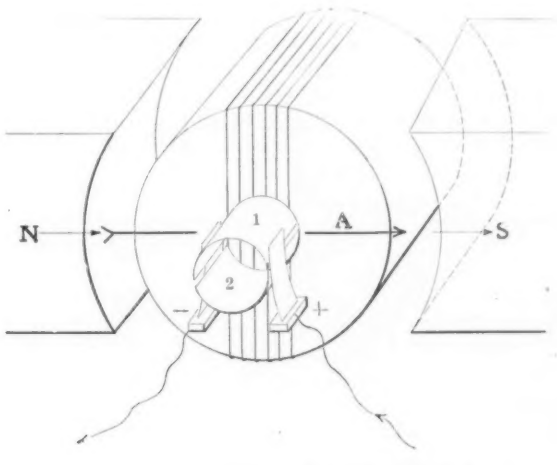


FIG. 267. POSITION OF MINIMUM PULL

Tests on a 35-Inch Exhaust Fan

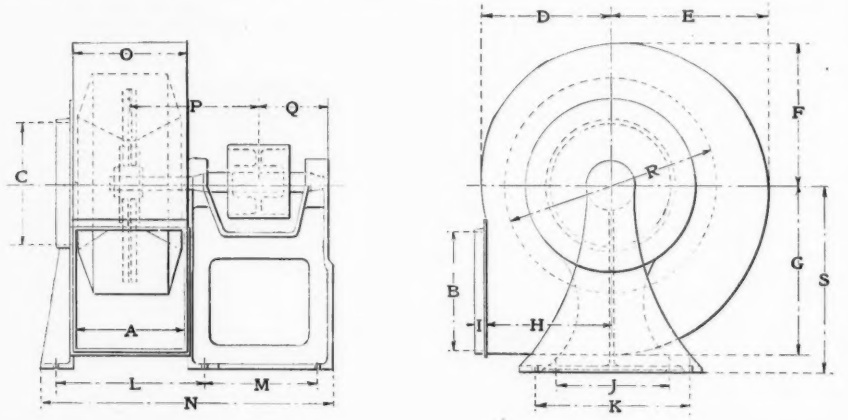
Results of an Interesting Investigation to Determine to What Extent the Loss of Power May be Decreased by Using Ball Bearings

BY PROF. CHARLES H. CHASE

The general subject of moving air by fans is receiving an increasing amount of attention both in its application to mechanical draft, to heating and ventilation and to the conveying of light material from place to place. The efficiency of the fan as a centrifugal air pump is consequently becoming a matter of greater importance and whatever means is used for decreasing the power lost in the fan must be of general interest. Perhaps one of the most obvious ways of reducing the losses is to lessen the friction of the bearings.

To determine how much may be expected under ordinary conditions along this line, the writer, assisted by Edwin B. Rollins, instructor in electrical engineering, conducted some tests during the past college year in the engineering laboratory at Tufts College and the results, together with other data taken, are here recorded.

The ball-bearing fan was taken from the regular stock of the Massachusetts Fan Company. It was provided with an interchangeable set of babbitted bearings. Each set of bearings had its individual shaft on which the wheel could be keyed. The general dimensions of the standard ball-bearing fan are shown in Fig. 1.



SIZE	OUTLET		INLET	SCROLL					I	J	K	L	M	N	O	P	Q	R	S
	A	B	C	D	E	F	G	H											
25	$8\frac{1}{2}$	$10\frac{1}{4}$	10	$10\frac{1}{2}$	$12\frac{1}{2}$	$11\frac{1}{2}$	$13\frac{1}{2}$	$10\frac{3}{8}$	$1\frac{1}{4}$	9	12	$12\frac{3}{4}$	10	$25\frac{3}{4}$	$9\frac{1}{4}$	$11\frac{3}{8}$	$6\frac{5}{8}$	18	15
30	$10\frac{1}{2}$	$11\frac{1}{2}$	12	$12\frac{1}{2}$	15	$13\frac{3}{4}$	$16\frac{1}{4}$	12	$1\frac{1}{4}$	11	$14\frac{1}{2}$	$14\frac{3}{4}$	11	$28\frac{3}{4}$	$11\frac{1}{4}$	$12\frac{7}{8}$	$7\frac{1}{8}$	21	18
35	$12\frac{1}{2}$	$13\frac{1}{2}$	14	$14\frac{1}{2}$	$17\frac{1}{2}$	16	19	14	$1\frac{1}{4}$	13	$17\frac{1}{2}$	$16\frac{3}{4}$	12	$31\frac{3}{4}$	$13\frac{1}{4}$	$14\frac{3}{8}$	$7\frac{5}{8}$	24	21
40	14	16	16	$16\frac{1}{2}$	20	$18\frac{1}{4}$	$21\frac{3}{4}$	16	$1\frac{1}{4}$	15	$20\frac{1}{2}$	19	$13\frac{1}{2}$	$36\frac{1}{4}$	$14\frac{3}{4}$	$16\frac{1}{8}$	$8\frac{5}{8}$	27	24
45	$15\frac{1}{2}$	18	18	$18\frac{1}{2}$	$22\frac{1}{2}$	$20\frac{1}{2}$	$24\frac{1}{2}$	$17\frac{3}{4}$	$1\frac{1}{4}$	17	23	$20\frac{1}{2}$	$14\frac{1}{2}$	$38\frac{3}{4}$	$16\frac{1}{4}$	$17\frac{3}{8}$	$9\frac{1}{8}$	30	27
50	17	20	20	$20\frac{1}{2}$	25	$22\frac{3}{4}$	$27\frac{1}{4}$	$19\frac{1}{2}$	$1\frac{1}{4}$	$19\frac{1}{2}$	26	22	$17\frac{1}{2}$	$43\frac{1}{4}$	$17\frac{3}{4}$	$19\frac{5}{8}$	$10\frac{5}{8}$	33	30
55	$18\frac{1}{2}$	$22\frac{1}{2}$	22	$22\frac{1}{2}$	$27\frac{1}{2}$	25	30	$21\frac{1}{2}$	$1\frac{1}{4}$	21	27	$23\frac{1}{2}$	$18\frac{1}{2}$	$45\frac{3}{4}$	$19\frac{1}{4}$	$20\frac{7}{8}$	$11\frac{1}{8}$	36	33
60	20	25	24	25	$30\frac{1}{2}$	$27\frac{3}{4}$	$33\frac{1}{4}$	24	$1\frac{1}{4}$	21	30	25	$20\frac{1}{2}$	$49\frac{1}{4}$	$20\frac{3}{4}$	$22\frac{5}{8}$	$12\frac{1}{8}$	40	36

FIG. 1. GENERAL DIMENSIONS OF THE FAN TESTED

On several occasions, before the tests with ball bearings were made, there was a considerable amount of dust in the air from a paving-brick testing machine located nearby and the fan stood uncovered most of the time. Apparently, little dust entered the bearings. The plain babbitted bearings were cleaned, smoothed with a scraper and kept well supplied with lubricating oil during the tests. The ball bearings were run just as they came from the makers, packed in vaseline.

Under these conditions, which are noted in order to show that they were not especially favorable to the ball bearings, the results of the tests gave an average saving in the power required to do equal amounts of work of 8.3 per cent. in favor of the fan with ball bearings.

The fan is listed in the maker's catalog as "size 35." The diameter of the wheel from tip to tip of the fan blades is 24 inches and the width of blade at its tip is 8 inches. The inlet diameter in the casing is 14 inches and the outlet is $12\frac{1}{2}$ x $13\frac{1}{2}$ inches. The accompanying drawings will give additional information with reference to the manner of applying the ball bearings, also with regard to the fan casing and the fan blades.

On the exhaust fan, Chapman ball bearings are used, Fig. 2, and are made a close fit in the hanger casting. The hardened conical sleeves carried by the shaft are well seated, but of such a taper as to allow the shaft to be driven free without excessive pressure. (It was convenient to do this in changing over from using the ball bearing to the plain bearings in order to avoid opening the joint in the double Indian tan endless belt.) Small steel balls, each held in a steel sleeve, separate the large balls that take the load.

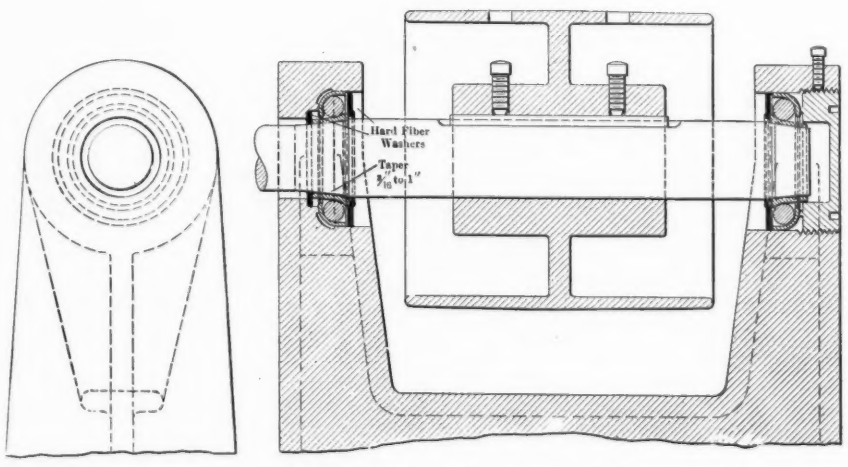


FIG. 2. THE BEARINGS USED IN THE TEST

The fan casing, Fig. 1, is of steel plate except the inlet and outlet frames and base, which are of cast iron. It may be arranged to discharge in any direction tangential to the circle of rotation. The

fan wheel has five radial blades supported by arms from the hub, each with its edge next to the inlet bent as shown in Fig. 3. It is of the "long-shaving" planing-mill type without side plates.

Power was furnished by a 10-horse-power shunt-wound motor, with several sizes of pulleys to give the required range in speed. The revolutions per minute were taken at the motor by a magneto and a voltmeter and checked by a speed counter, and at the fan by a speed counter after the adjustment for the reading was made, using a hand tachometer. The same electrical instruments were used in all the tests and the readings were corrected for instrument error. The power delivered to the belt was found by subtracting the motor losses from the input to the motor. Separate determinations of the losses corresponding to the conditions were made at the time of the tests. Temperatures were taken with wet- and dry-bulb thermometers to determine the humidity of the air and the barometer readings were noted. To determine the volume of air discharged, several conical galvanized-iron nozzles were made having an angle of convergence of 6 degrees for which 0.92 is taken as the coefficient of discharge. The dimensions were based on the "capacity area" of the fan, which for this type is equal to "outside diameter of blades in inches $\times$ width of blade tip in inches $\div$ 3," or $\frac{DW}{3}$. (See POWER, May 19, 1908, "The Performance of Fan Blowers," by W. B. Snow.)

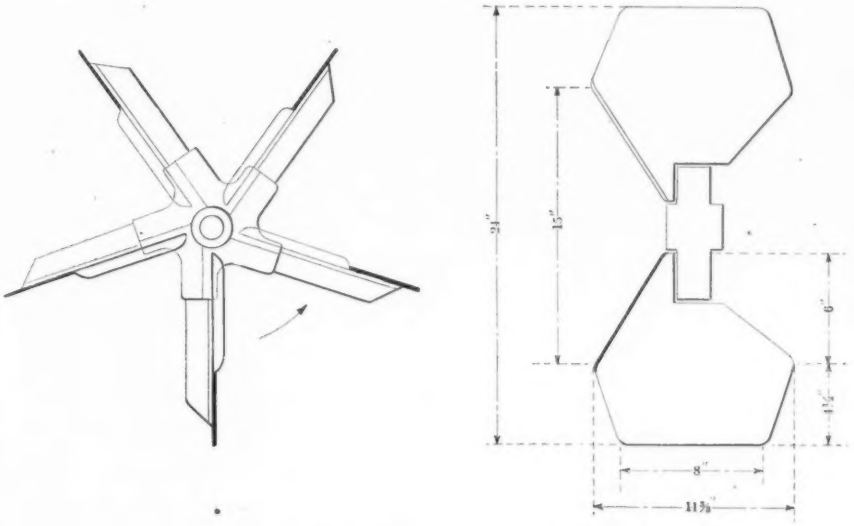


FIG. 3. RUNNER OF THE TESTED FAN

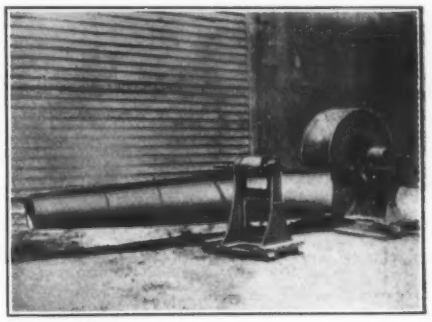


FIG. 4. SHAPE OF NOZZLE

The nozzles shown in Fig. 4 were made of such lengths that the diameters at the outlets would give effective areas of discharge equal to ¾, 1, 1½ and 2 times the "capacity area." Thus:

$DW \div 3 = 24 \times 8 \div 3 = 64.$

$0.75 \times 64 \div 0.92 = 52.2$ square inches, or 8⅛ inches in diameter.

$1.00 \times 64 \div 0.92 = 69.6$ square inches, or 9⅜ inches in diameter.

$1.5 \times 64 \div 0.92 = 104.3$ square inches, or 11½ inches in diameter.

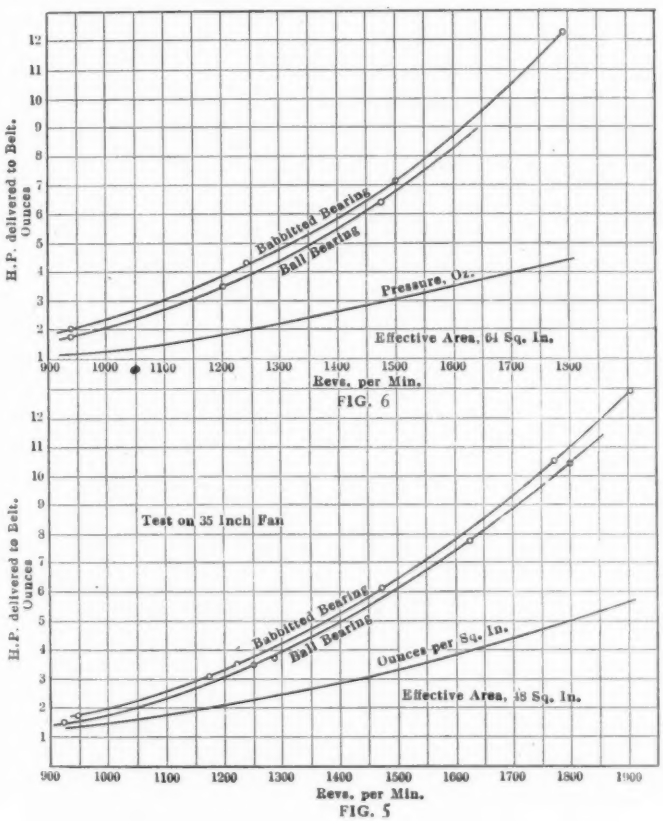


FIG. 6

FIG. 5

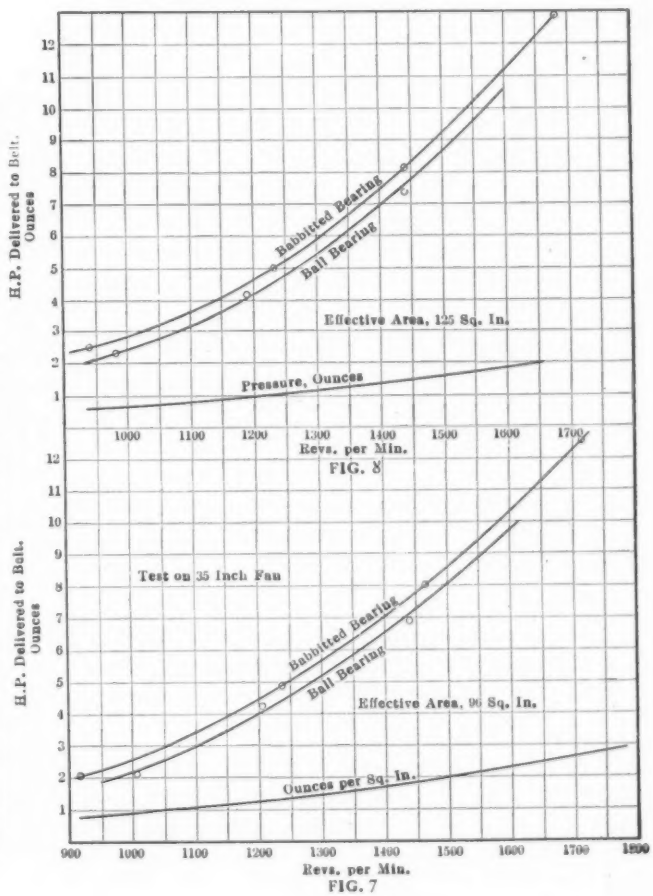


FIG. 8

FIG. 7

$2.0 \times 64 \div 0.92 = 139.1$ square inches, or 13¼ inches in diameter.

The first or fixed nozzle was made 4 feet long, bringing the size from the rectangular outlet on the fan casing to 13¼ inches diameter at the nozzle outlet. As this did not permit of the 6-degree angle, it was considered best to take the coefficient as 0.90 for this nozzle, making the multiplier 1.95 instead of 2. The effective areas for the nozzles were then 48, 64, 96 and 125 square inches, respectively.

Air pressures at the nozzle, or velocity heads, were measured in inches of water by a U-tube connected to a Sanborn piezometer. This had been checked in connection with other Pitot tubes on air pressure and the results found to agree within the limits of reading. To find the volume discharged it is necessary to determine the velocity due to the pressure as shown by the U-tube readings, and in accordance with the conditions of temperature and humidity of the air. To obtain the weight of a cubic foot of air, reference was made to Weather Bulletin No. 235, United States Department of Agriculture, 1900. The velocities found from these data (see "Mechanical Draft," B. F. Sturtevant Company, pp. 146-147, or the article previously quoted) agreed with the values shown in tables of "Mechanical Draft" within less than 1 per cent., and consequently the values corresponding to the pressures were then taken from the tables, taking into account also the difference in temperatures.

The curves drawn in Figs. 5 to 8 are from the reduced data, and show the difference in power taken at the different speeds with the two sets of bearings. In Fig. 9 the curves are derived from the horsepower curves by plotting the revolutions corresponding to the same powers with the two types of bearings in connection with the effective areas. Figs. 10 and 11 were plotted from the data in preparation for the plotting of Fig. 12, which shows the characteristic curves of the fan through the range of the tests and with both sets of bearings. For instance, at 4 horsepower the revolutions per minute are found from Fig. 6 to be 1220 and 1260 for the plain and ball bearings, respectively, and from Fig. 10 at 64 square inches effective area, the cubic feet of air, per minute, dividing which by 33,000 gives the horsepower output. The input horsepower is taken from the curves. It is noteworthy that the highest efficiency of the fan is at or near its capacity area. Calculation for efficiency at 1500 revolutions per minute shows a slight increase over that shown at 1200 revolutions on Fig. 13.

From Fig. 12 it is evident that when 4 horsepower was delivered to the belt and the area of the outlet was the capacity area, the volume of air discharged was 3300 cubic feet per minute with babbitted bearings and 3420 with ball bearings, but in the latter case at a higher pressure. Interpolating on the 4-horsepower curve for ball bearings at the same pressure as for the plain bearing gives a volume of 3550 cubic feet per minute. This is an increase of 7.6 per cent. in air delivered at equal pressures for the same power, and checks fairly well with the percentage of increase in efficiency of the fan at 1200 revolutions per minute and at the capacity area as shown in Fig. 13, from which we have $100\ (50.1 - 46.1) \div 46.1 = 8.7$ per cent. increase.

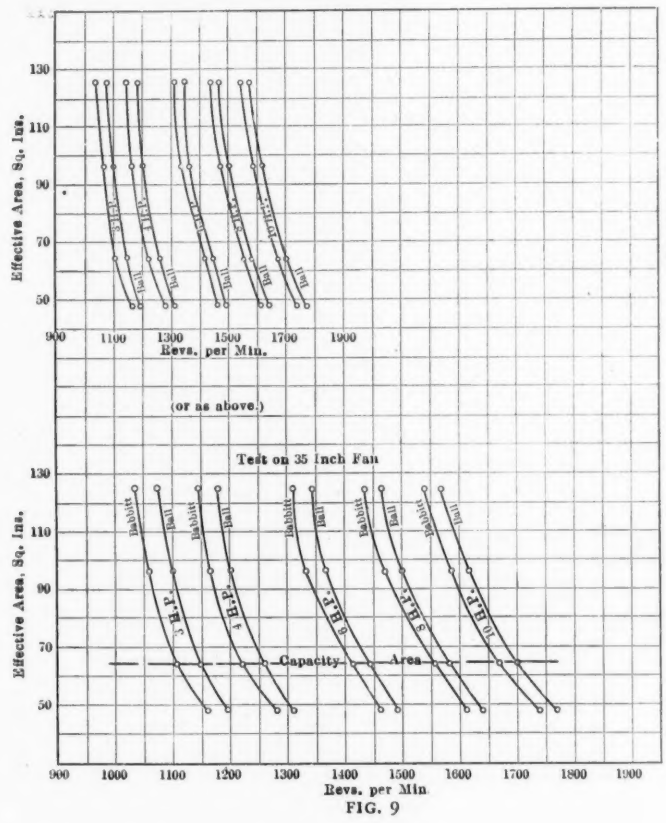


FIG. 9

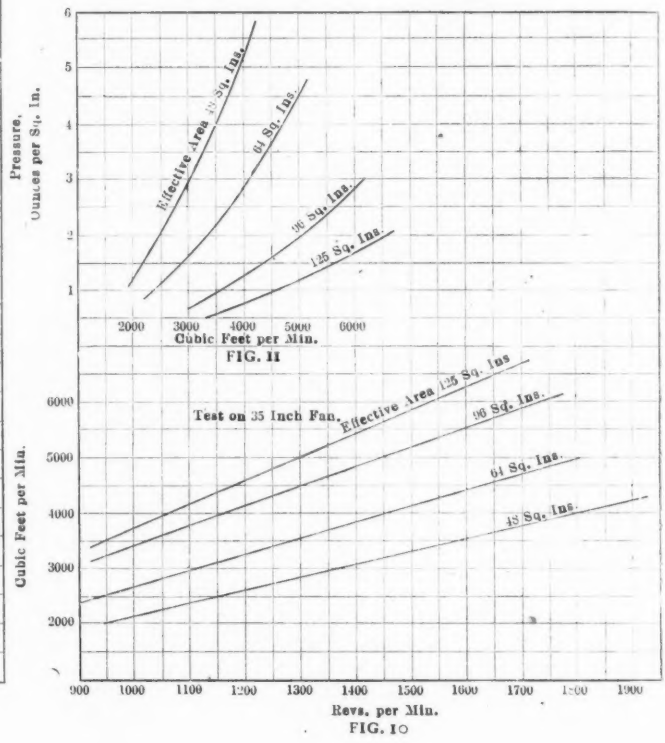


FIG. 10

FIG. 11

It will also be noted from Fig. 12 that for the same speed and horsepower a much larger percentage in volume can be delivered by the fan with ball bearings, but at a lower pressure.

The saving in power by the use of the ball bearings may be stated as a percentage and found thus: In Fig. 6, at 1355 revolutions per minute, at which the pressure due to velocity head is 2.45 ounces per square inch, 5 horsepower is required by the fan using ball bearings,

and 5.35 horse-power with the babbitted bearings, or an increase over the power taken by the fan with ball bearings of $0.35 \div 5 = 0.07$, or 7 per cent. In this way the saving was calculated for each discharge area through a range from 3 to 9 horsepower, giving for the areas 48, 64, 96 and 125 square inches, an average saving of 7.2, 8.4, 8.6, and 8.8 per cent., respectively. For each nozzle the amount of gain by use of the ball bearings varies from about 11 per cent. at 3 horsepower to 5.5 or 6 per cent. at 9 horsepower. The accuracy of these figures depends upon the closeness with which the curves represent the data, but the mean value of 8.3 per cent. saving probably represents fairly the existing conditions.

Naval Constructor D. W. Taylor has suggested* that it is best for measurement of velocity heads to locate the nozzles at a distance of 20 or so diameters away from the fan outlet, partly perhaps to allow the flow to become steady. For these tests this was not done because the main part of the test was to determine relative powers, and the space used did not permit. The distance from the fan outlet to the end of the smallest nozzle was 8 feet and the U-tube readings were quite steady. The average temperature during the tests was 87 degrees Fahrenheit, except when the ball bearings were in use with the smallest nozzle; then it was 72 degrees Fahrenheit.

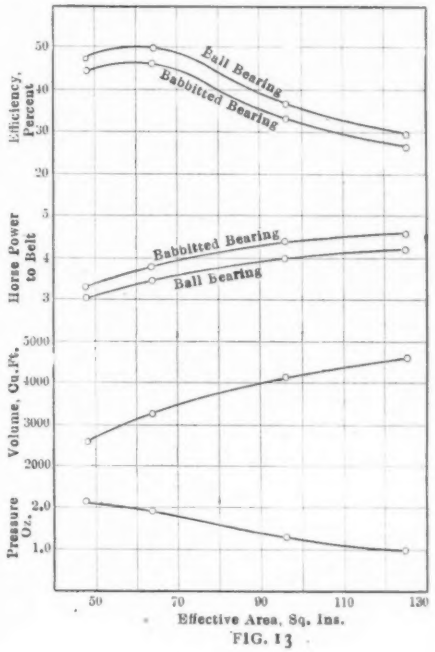


FIG. 13

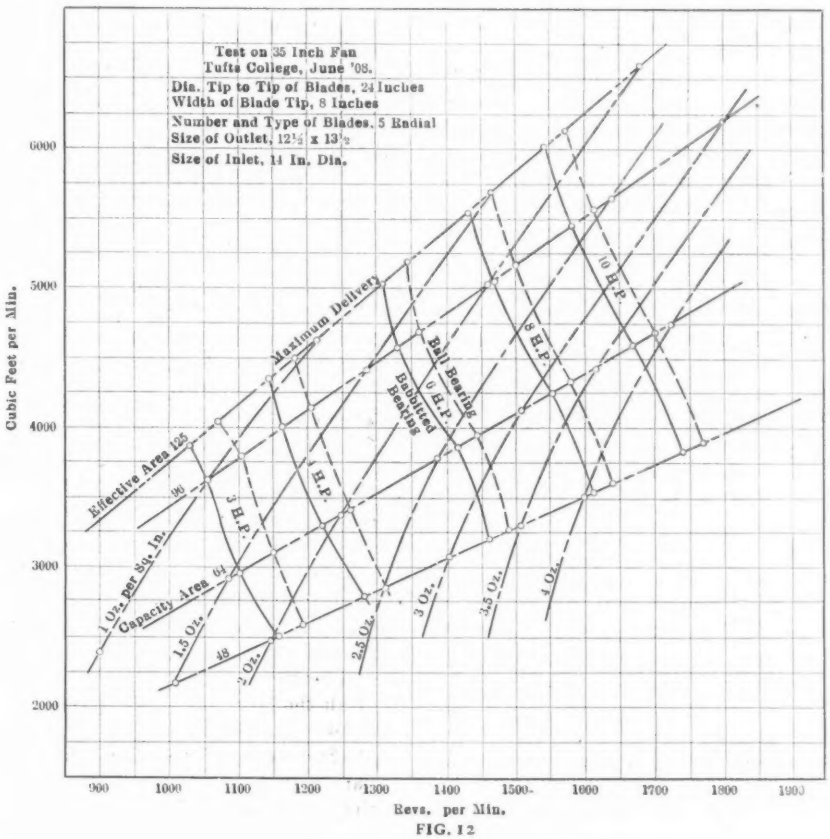


FIG. 12

*Transactions of the Society of Naval Architects and Marine Engineers, Vol. 13, 1905.

Water Power Development in New York State

The General Assembly of New York, by the passage in 1907 of what is known as the "Fuller Bill," took an advanced stand upon the principle of State ownership and control of one of the State's greatest natural assets, namely, the vast water powers within its borders, and appropriated the sum of $35,000 to be expended by the State Water Supply Commission in collecting information relating to the water powers of the State and in devising plans for the development of such water powers.

The commission has lost no time in carrying out the purposes of the legislature and was fortunate in securing the services of John R. Freeman as its engineering advisor.

Excluding the Niagara and the St. Lawrence, the rivers of the State, with the proper storage of their flood waters, are capable of furnishing at least a million horse-power for industrial purposes. The minimum flow being the real test of the power value, at least 55 per cent. of their potential energy is lost to the owners of water rights and to the people of the State. It is clear, therefore, that 550,000 horse-power of energy is annually allowed to run to waste because no well-devised and comprehensive plan for the general and systematic development of water power has been undertaken by the State.

At a low estimate, the advantage of water over steam power is at least $12 per horse-power per year. The annual earning capacity of the wasted energy based on even so low an estimate is $6,600,000. Add to this the $1,000,000 per year of direct damage caused by floods and the indirect damage which no one has been able to determine, but which is surely equal to the direct damage, and the value of an equalized flow during the summer months in the great rivers, together with the possibilities to be derived from the proper treatment of the Niagara and St. Lawrence, and the aggregate will give some idea of the value to be obtained by the systematic development and increase of the water powers of the State.

Up to this time there has not been, and under present conditions there cannot be, such economical and general development of water power by private interests as would include the storing of flood waters on a scale at all commensurate with the advantages to be gained therefrom. It is from this method that the greater amount of increase is to come. Moreover, the individual or corporation that invests money usually does so in the hope of immediate gain. There is, therefore, the temptation to cut out of the work everything that can be postponed or avoided, no matter how essential it may be to the future success of a well-considered plan. The storing of flood waters will not only provide power development at the site of the dam, but will also increase the power of every user on the stream. The fear of improving the plant and power of a competitor might well restrain an owner of water power from going farther up the stream and building a storage dam that would increase the value of his neighbor's plant as well as his own. It is also very difficult for several interests to combine in the aid of such a project. Even though they might be willing to engage in a joint enterprise for such a purpose,

there would be still the lack of power to condemn land for storage purposes, for which recourse must be had to the law-making body.

The United States census of manufacturers for 1905 shows that 27½ per cent. of the 1,647,969 horse-power developed by water in the United States for manufacturing purposes was used in the State of New York. This is more than twice as much as that used by its principal competitor, the State of Maine, and more than half as much as the total steam power for like purposes used in the State. The increase of water power in this State from 1900 to 1905 was more than 100,000 horse-power.

By means of storage dams constructed by the State at available points, in order to hold back the flood waters of many of our large rivers, it is possible so to equalize their flow as to more than double the available horse-power they now produce. Such improvement can be made to yield a revenue that will not only pay the cost of constructing and maintaining the dams, but will provide a large income for the State for all time.

The State Water Supply Commission believes that through the building by the State of storage dams, thus conserving water for power purposes, five distinct advantages will accrue:

(1) The construction of such dams will decrease the annual damage by flood waters.

(2) It will assure a larger minimum flow which will improve sanitary conditions.

(3) It will provide a deeper channel for the Hudson river, thus improving navigation and insuring an abundance of water for the increasing needs of the canals.

(4) It will provide cheaper power for manufacturing purposes and, by stimulating various industries, furnish larger fields of employment, while insuring uninterrupted labor in already existing plants.

(5) It will provide a satisfactory annual income to the State.

In company with its engineer, the commission has made an inspection of several of the watersheds of the State and has just issued a comprehensive report of 252 pages, from the introduction of which the above excerpts have been drawn, and which contains the detailed study by its engineers of sites on the Sacandaga river, near its confluence with the Hudson, and on the Genesee river, near the Portage falls.

The Sacandaga river rises in the Adirondack mountains and is 65 miles long from its source to Conklinsville, the site of the proposed dam, having a drainage area of 1050 square miles. From the work already done, it appears entirely probable that a safe and suitable site for a dam can be located at or near Conklinsville that will cover an area of 40 square miles and store about 26,000,000,000 cubic feet of flood water; that the Sacandaga river thus dammed at this point will furnish a sufficient amount of water to produce 60,000 horse-power, which is greater than the aggregate water power of Lowell and Holyoke, Mass., or will increase the present available force at sites lower down the Hudson by 70,000 horse-power for the six dry months of the year.

Surveys and test borings have been made at Hadley for the purpose of determining whether a storage dam can be built at this place across the Hudson, which will economically increase the power development in each of the thirteen power sites lower down the river.

On the Genesee river the commission has studied the advantages of a great natural power site at Portage. The outlines of the proposed development include the building of a storage dam near the Pennsylvania Railroad bridge at Portageville, which would flood an area extending 15 miles up the river averaging a mile in width, forming a lake of 15 square miles surface area, and storing 18,000,000,000 cubic feet of water, or sufficient to provide a yearly average flow of 1800 cubic feet per second for power purposes. The site for the power station would be near the hamlet of St. Helena, about five miles down the river, as it flows, and beyond the limits of the Letchworth park. In a line from the dam to the power house, a tunnel 3 miles long and 18 feet in diameter would be built, running in places 200 feet underground. The net working head at the power plant will be 500 feet, which would permit a gross development of thirty-two thousand 24-hour horse-power and increase by nearly 20,000 the actual 24-hour horse-power now developed at Rochester. With use concentrated in working hours, the horse-power will be more than doubled. Such development on a basis of only $12 per 24-hour horse-power per year would produce an annual revenue of $384,000 at the power station and $240,000 at Rochester, besides immunity from floods and the benefit by increasing the low-water flow of the river, removing the nuisance caused by the city sewers.

Lord Kelvin, after a superficial examination of the maps and charts of the watershed, has stated: "The proper method of utilizing the water power of the Genesee river is to construct small, comparatively cheap dams wherever on the watershed pondage can be obtained giving a supply of several months." The commission finds that there are on the tributaries of the Genesee above Portage twelve possible dam and reservoir sites, that the combined storage capacity of these reservoirs would only be 3362 million cubic feet and that it would cost $1200 per million cubic feet, or $4,031,100, for the twelve storage dams and reservoirs. This amount of storage is so small that it would be wholly inadequate for either flood protection or power purposes, and the cost would be out of all proportion to the benefits that could be derived therefrom. At Portage, a dam and reservoir that will store five times as much water can be built and the cost per horse-power will only be one-fourth as great.

The commission has also made a study of the possibilities of the Racquette river, the elevation of the head waters of which brings it into the region of high rain-fall, the annual rain-fall in that locality being 48 inches, while the average rain-fall throughout the State hardly exceeds 38 inches per year. A committee which studied the subject for the water-storage commission in 1902 reported that 20,000,000,000 cubic feet of water could be stored in this region at a cost of $50,000 for dams. The statement does not include land damages and this estimate may be, and probably is, far too small. It is true, nevertheless, that there can be erected by the State a series of dams forming reservoirs that would yield a large revenue to the State. These developments will add to rather than detract from the natural beauty of the country, transforming low and unsightly lands into attractive and beautiful lakes.

The commission is able as yet to make only a cursory summary of the conditions along the Delaware, which river has a length of 105 miles in New York State and a drainage area of 2570 square miles. It has an average fall within the State of 7 feet to the mile and at Port Jervis, where it leaves New York, it exceeds in volume the Mohawk at its mouth and the Hudson at Schuylerville. In 1880 there were 273 water powers in use on this river and there has been a steady decrease in their number, which is keenly felt by property owners along the river. Plans have been proposed by interested persons for the storage and control of its waters by the erection of a series of dams which shall hold at least 26,000,000,000 cubic feet of water. These plans contemplate about 40 reservoirs and also a series of river basins in the stream itself each from 5 to 10 miles long. By so equalizing the river flow it is claimed that this project will secure safe and advantageous power development, and in addition will convert the region into a beautiful and attractive pleasure resort and greatly add to land values. The commission has under contemplation the advisability of having a conference upon the subject of water storage with the representatives of the States of New Jersey and Pennsylvania, in which State commissions having powers similar to those of the New York commission have been created.

Fifty feet of natural gas burned in a boiler furnace will develop one boiler horsepower-hour.

On turning the current off an arc lamp, if the lower carbon stays red the longer the lamp is burning upside down and the wires should be reversed.

The Piping Systems of High Pressure Plants

Directions for Arranging Steam and Water Piping for Power Plants, Showing the Most Desirable Methods for Various Conditions

BY CHARLES L. HUBBARD

Size of Water Piping

The size of feed-pipe is usually governed by the discharge outlet of the pump. Special makes of boilers, feed-water heaters, etc., have the size of feed connections fixed, so that in piping up the different pieces of apparatus it is merely a matter of proportioning the pipes to the openings to be connected. In the case of tubular boilers the size of feed-pipe is usually fixed by custom, and depends upon the diameter of the boiler.

Table 3 may be taken as about the average practice.

TABLE 3.

Dia. of Boiler. In.	Size of Feed-pipe. In.
42	1
48	1
54	1¼
60	1¼
66	1½
72	1½

The common method of proportioning pipe sizes is to make the total sectional area of the branches equal to that of the main, although as a matter of fact it should be somewhat greater. This is true because for a given area and velocity of flow there will be less frictional resistance in a single large pipe than if the same quantity of water were passed through several smaller pipes having the same total area. Table 4 gives the internal area in square inches of several sizes of standard wrought-iron pipe, and Table 5 takes into account the frictional resistance as noted above and shows the number and size of branches which a given main will supply.

TABLE 4.

Diameter of Pipe. In.	Internal Area. Sq.In.	Diameter of Pipe. In.	Internal Area. Sq.In.
¾	0.53	3	7.4
1	0.86	3½	9.9
1¼	1.5	4	12.7
1½	2.0	5	20.0
2	3.3	6	28.9
2½	4.8	8	50.0

TABLE 5.

Main.	Branch.
1″ will supply	Two ¾″.
1¼″ will supply	Two 1″.
1½″ will supply	Two 1¼″.
2″ will supply	Two 1½″.
2½″ will supply	Two 1¼″ and one 1¼″ or One 2″ and one 1½″.
3″ will supply	One 2½″ and one 2″ o Two 2″ and one 1½″.
3½″ will supply	Two 2½″ or One 3″ and one 2″ or Three 2″.
4″ will supply	One 3½″ and one 2½″ o Two 3″ and four 2″.
4½″ will supply	One 3½″ and one 3″ or One 4″ and one 2½″.
5″ will supply	One 4″ and one 3″ or One 4½″ and one 2½″.
6″ will supply	Two 4″ and one 3″ or Four 3″ or Ten 2″.
7″ will supply	One 6″ and one 4″ or Three 4″ and one 2″.
8″ will supply	Two 6″ and one 5″ or Five 4″ and two 2″.

These methods are sufficiently accurate for boiler-room work where the distances are short, but in the case of long runs of pipe such as the mains in forced hot-water heating, and the suction and discharge of pumps moving large quantities of water long distances, it is necessary to compute the sizes more accurately by means of a table giving the flow of water through pipes under different pressure-heads.

Water Pressure and Head

If several open vessels containing water are connected by pipes, the water will eventually stand at the same level in all of them, regardless of the length or the size of the connecting pipes. The pressure exerted by a liquid at any given point is the same in all directions, and is proportional to the depth.

A column of water at 60 degrees temperature, having a sectional area of 1 square inch and a hight of 1 foot, weighs 0.43 pound, and the pressure exerted may be expressed in feet of head or pounds per square inch. If, for example, a closed vessel is connected by means of a pipe with an open vessel at a higher level, so that it is 10 feet from the bottom of the first vessel to the surface of the water in the second, the pressure on each square inch of the entire bottom of the lower vessel will be 10×0.43 pound, and the pressure per square inch at any given point in the vessel or connecting pipe will be equal to its distance in feet from the surface of the water in the upper vessel multiplied by 0.43.

If a pipe is carried from a reservoir situated on the top of a hill to a point at the foot of the hill, a hundred feet below the surface of the water, a pressure of

$$100 \times 0.43 = 43$$

pounds per square inch will be exerted at the lower end of the pipe, provided it is closed. Another way of expressing the same condition is to say the water in the pipe is under a head of 100 feet. When the lower end of the pipe is opened and the water begins to flow, the conditions are changed and the pressure in the different parts of the pipe varies with the distance from the open end.

In order for a liquid to flow through a pipe there must be a certain pressure or head at the inlet end. The total head causing the flow is divided into three parts, as follows: First, the velocity head, the hight through which a body must fall in a vacuum to acquire the velocity with which the liquid enters the pipe; second, the entry head, that required to overcome the resistance to entrance into the pipe; third, the friction head, due to the frictional resistance to flow within the pipe. In the case of long pipes and low heads the sum of the velocity and entry heads is small compared with the friction head and in ordinary work may usually be neglected.

TABLE 6. FRICTION HEADS FOR DIFFERENT VELOCITIES OF FLOW.

Gallons Per Minute.	2-inch Pipe.		2½-inch Pipe.		3-inch Pipe.	
	Velocity in Feet Per Second.	Friction Head in Lbs. Per Sq.In.	Velocity in Feet Per Second.	Friction Head in Lbs. Per Sq.In.	Velocity in Feet Per Second.	Friction Head in Lbs. Per Sq.In.
50	5.1	2.4	3.3	0.8	2.3	0.3
75	7.7	5.3	4.9	1.8	3.4	0.7
100	10.2	9.5	6.5	3.2	4.5	1.3
125	12.8	14.9	8.2	4.9	5.7	2.0
150	15.3	21.2	9.8	7.0	6.8	2.8
175	17.1	28.1	11.4	9.5	7.9	3.8
200	20.4	37.5	13.1	12.5	9.1	5.0
250	....	....	16.3	19.7	11.3	7.8

Table 6 is a small portion taken from a table of "friction heads" and used here for purposes of illustration. It gives the friction head for different velocities of flow through pipes of different diameters, and the corresponding number of gallons discharged per minute. The friction heads are given in pounds per square inch, and represent the pressure required to force water at the given velocity through a horizontal pipe 100 feet in length.

As the frictional resistance is proportional to the length, the friction head for any other length of run can be found by

multiplying the number given in the table by the given length, divided by 100, that is, for 1000 feet, multiply by 10, and for 50 feet, multiply by 0.5. The use of Table 6 can best be shown by one or two practical examples.

Example 1—It is desired to circulate 250 gallons of water per minute through a heating main 500 feet long, at a velocity of about 12 feet per second. What size of pipe will be required, and what pressure per square inch must be exerted by the pump to overcome the frictional resistance?

Looking in the table along the line corresponding to 250 gallons, we find that a 3-inch pipe will discharge this quantity at a velocity of 11.3 feet per second, with a friction head of 7.8. This, however, is for a pipe 100 feet in length, and for 500 feet the required pressure would be

$$5 \times 7.8 = 39$$

pounds per square inch.

Example 2—A pump having a 2-inch discharge is used to force water into a tank situated on an elevation 100 feet above it and 800 feet distant. What pressure per square inch must the water piston of the pump exert to deliver 50 gallons per minute?

The pressure to be overcome by the pump consists of two parts, the weight of a column of water 100 feet high, and the frictional resistance within the pipe. The first of these is equal to

$$100 \times 0.43 = 43$$

pounds per square inch, and the second from the table is found to be 2.4 pounds for a pipe 100 feet long, or

$$8 \times 2.4 = 19.2$$

pounds for 800 feet. The total pressure is, therefore,

$$43 + 19.2 = 62.2$$

pounds per square inch.

Wrought- and Galvanized-iron Pipes

Wrought-iron pipe is made "standard weight," "extra strong," and "double extra strong." The standard weight is commonly used for all pressures up to 125 pounds per square inch. The heavier weights are often used for higher pressures, although exhaustive tests made by manufacturers seem to show that standard-weight pipe is sufficiently strong for all pressures used in ordinary power work at the present time. When particularly exposed to corrosion it is well to use extra-heavy pipe. This applies to feed lines, sealed returns, underground drip piping, etc., and all lines which are to be run in places not easily accessible.

Nearly all of what is commonly known as wrought-iron pipe is in reality wrought steel. There seems to be no especial advantage in using iron in place of a good quality of steel, although some engineers prefer the former. Wrought-iron pipe is not carried in stock to any great extent, and if it is to be used in any considerable quantity, should be ordered well in advance of the time it is to be used.

The outside diameter of the extra-strong and double extra-strong pipe is the same as that of the standard weight, the extra thickness being added to the inside. This makes it possible to use the same fittings with any weight of pipe. Seamless-drawn brass and copper tubing may be had in sizes corresponding to standard wrought-iron pipe. This material is used for hot-water service, for connections between feed-pumps and boilers, for the attachment of boiler trimmings and for steam-heating coils in hot-water boilers. It is more durable than iron pipe when in contact with hot water, and its freedom from rust makes it especially adapted for hot-water service in connection with laundry and similar work.

Spiral-riveted galvanized-iron pipe is quite frequently used for exhaust lines and low-pressure heating mains of large size. It has the advantage of lightness, and is lower in cost than standard wrought-iron pipe. It is made up with flanged fittings for steam work like those employed for other kinds of pipe.

Cast-iron Fittings

These fittings, both screwed and flanged, are used for all classes of steam work, and are commonly made in three weights. The lightest for low pressures, such as exhaust or condenser connections; standard weight, for pressures up to 100 or 125 pounds per square inch, and extra heavy for higher pressures up to 250 pounds per square inch.

For low steam pressures the flanges are simply screwed onto the pipe ends, a thin gasket of sheet packing being placed between them and then drawn together with bolts. For higher pressures more care must be taken to make the joints tight and durable. Flanges are commonly made in three ways, as follows: Those with a plain face, Fig. 12; tongue and groove, Fig. 13; and with a raised face inside the bolt holes, Fig. 14.

There are various methods of securing the flange to the pipe in order to make a tight joint. One of the simplest and most satisfactory, considering first cost, ease of repairing and freedom from leaks, is made by threading the pipe with a full taper, then screwing on the flange by power until the end of the pipe projects about 1/16 inch, and facing off in a lathe. Another method is to round off the inner edge of the flange and expand or peen over the end of the pipe, as shown in Fig. 15, and then face in a lathe as before.

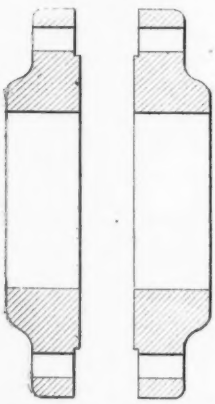


FIG. 12. PLAIN FACE

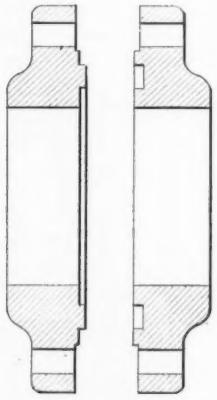


FIG. 13. TONGUE AND GROOVE

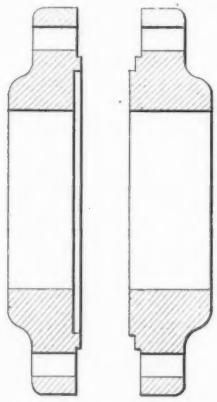


FIG. 14. RAISED FACE

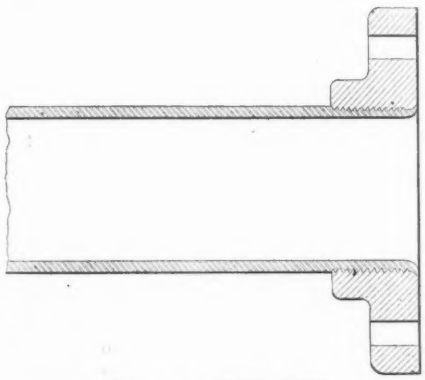


FIG. 15. A TIGHT JOINT

Flanges are sometimes shrunk in place, and also riveted. With the latter arrangement the joint is apt to leak after a time around the rivets.

Where especially fine work is desired, and the first cost does not prohibit it, wrought-iron pipe may be used with flanges of the same material welded in place. Work of this kind must be done where the pipe is manufactured.

The principal objection to the tongue-and-groove joint and also to the raised face when the depth of step is too great, is the difficulty of springing apart a line of heavy piping to remove a section, or for repacking the joint.

For high-pressure piping with faced flanges there is probably nothing better in the way of gaskets than the best quality of corrugated copper. These are usually made small enough to fit inside the bolt circle, although they are sometimes punched for the bolt holes and made the same size as the flange. There is nothing to be gained, however, by the lat-

ter arrangement, and the narrow gasket is now used in the best class of work. This type of gasket can be used both with the plain and raised-face flange. Special forms of copper gaskets are also made for the tongue and groove joint.

Sheet packing is made in various grades. The best pure sheet packing is composed of rubber and certain heat-resisting materials properly mixed and vulcanized. For high-pressure work with faced flanges, the packing should not be over 1/16 inch in thickness; for low-pressure work and where the flanges are more or less uneven, it should be about ⅛ inch in thickness. There are a number of metallic and semi-metallic packings upon the market, each claiming its own particular advantages.

Pipe Hangers

Hangers of various patterns are used for supporting steam and return pipes in overhead positions. When the ceiling construction is of wood they are usually held in place by lag screws, screwed into the beams or joists. When fire-proof construction is used, the hangers are either clamped to the lower flanges of the I-beams or attached to iron plates, embedded in the masonry above the arches. The requirements of a satisfactory hanger are that it shall be adjustable to the proper alinement of the pipe and have sufficient lateral movement to swing with the expansion of the pipe without straining. Hangers are usually placed from 10 to 12 feet apart on straight runs of pipe, with extra ones at bends or where other special conditions require them.

Spring hangers are sometimes employed when piping connections with high-speed engines is supported from the floor above, in buildings where vibration is objectionable. In case hangers of this kind are used, some form of safety device should be employed for catching the pipe, as the constant vibration of the piping is almost sure to weaken the springs after a time.

Provision For Expansion

Pipe bends of various forms are commonly used in making connections about boilers and engines for taking the strains due to expansion. Connections made up in this way are less rigid than when straight lengths of pipe and cast-iron fittings are used. Pipe bends are often employed in hot-water or steam work where it is desired to reduce the friction in the pipe to the smallest amount. These bends are made to order to a minimum radius equal to five diameters of the pipe. From 4 to 6 inches of straight pipe should be allowed at each end next to the flange.

Table 7 shows the expansion of wrought-iron pipes when steam at different pressures is turned into them. From the table it is evident that in laying out a system of piping care must be taken to provide for this increase in length without producing excessive strains upon the pipe and fittings. In case of the smaller sizes, the expansion may be cared for by means of offsets and bends which allow the pipe to spring or give, but in larger sizes this simple method will not be sufficient unless the offsets are of considerable length, and swivels or slip-joints must be used to take up the expansion. If slip-joints are used on high-pressure work, they should always be balanced against the steam pressure acting upon the end of the pipe.

TABLE 7.

Temperature of Air When Pipes Are Filled.	Expansion per 100 Feet When Heated to			
	215° 1 Lb. Steam Pressure.	265° 25 Lb. Steam Pressure.	297° 50 Lb. Steam Pressure.	338° 100 Lb. Steam Pressure.
0 degrees	1.72″	2.12″	2.31″	2.70″
32 degrees	1.47″	1.78″	2.12″	2.45″
64 degrees	1.21″	1.61″	1.87″	2.19″

For pipes up to 3 or 4 inches in diameter where the amount of expansion is small the expansion loop is used to some extent. Copper was formerly used for loops of this kind, but on account of its low elastic limit and the liability of flaws in manufacture, it has been largely superseded by the best quality of mild steel.

Insulating Material

Steam pipes, separators, heaters, etc., should be covered with some good insulating material to reduce the amount of condensation, and incidentally to prevent to some extent the overheating of the engine and boiler rooms. Various materials are used for this purpose, the more common being carbonate of magnesia, asbestos, hair-felt, cork, and mineral wool. These are made up in various combinations and formed into canvas-covered sections about 3 feet in length. After being placed upon the pipe, the canvas flaps are pasted down and light metal bands drawn tightly around the ends and middle of each section to hold it in place.

Valves and fittings are covered either with molded or plastic material. The former consists of a mold of proper size and shape to inclose the fitting, made in two parts and held in place by a canvas covering and metal bands. Plastic covering is made by applying several thin coats of asbestos or magnesia in the form of a paste directly to the fitting, each being allowed to dry before the next is applied. This is given the proper shape, and after hardening is covered with canvas securely pasted to hold it in place.

Extended surfaces, like small boilers, heaters, smoke-pipes, etc., are usually covered with plastic material applied to a wire netting secured to the metal surface. A smooth finish is given when nearly dry by rubbing with a trowel. Sometimes a lagging of insulating blocks an inch or so in thickness is first wired to the metal surface, and this finished with a coat of plastic material.

Pipe coverings are usually made from 1 to 1¼ inches in thickness, this being the economical limit; any additional heat saved by using a thicker covering being slight when compared with the increased cost. Plastic covering possesses the advantage of being applicable to any shape of pipe or fitting, as well as boilers, heaters, separators, etc., but the covering cannot be removed for the inspection of joints and seams without being destroyed. Sectional covering can be taken off and replaced without damage, and is used almost exclusively for straight runs of pipe. Molded fittings are commonly used in the best class of high-pressure work, especially for flanges, while a plastic covering is usually sufficient in the case of low-pressure heating systems.

In selecting a covering, its durability should be considered as of equal importance with its non-conducting properties. Many coverings which show a good efficiency when new, deteriorate quite rapidly when placed upon a pipe line connected with high-speed engines or other machinery causing vibration.

Coverings containing corrosive substances, such as sulphate of life (plaster of paris) and sulphur should always be avoided. Carbonate of lime (chalk) is harmless so far as corrosion is concerned, but is reduced to a powder by vibration and thus rendered useless. Some of the inferior grades of mineral wool are apt to contain sulphur, which is likely to attack the pipe if it becomes moist.

Carbonate of magnesia and asbestos fiber both make durable and efficient coverings when properly made up, and in specifying the words "carbonate" and "fiber" should always be mentioned when referring to these materials. Cork makes a good covering when properly prepared. The granulated material is subjected to a high pressure in iron molds at a temperature of about 500 degrees. It commonly has a thin layer of asbestos next to the pipe and is provided with a canvas cover the same as other forms. This is especially adapted to places exposed to dampness, as the cork is impervious to moisture.

From bare pipes the heat loss varies from 2½ to 3 B.t.u. per square foot of surface per hour, for each degree difference in temperature between the steam and surrounding air, depending upon the size of pipe and the freedom with which the air circulates about it. A series of tests made some years ago at the Massachusetts Institute of Technology upon a dozen or more commercial coverings showed that from 75 to 84 per cent. of the heat lost from the bare pipe was saved. Taking the average as 80 per cent. and assuming a loss of 3 B.t.u. per square foot per degree difference per hour, the

saving to be made in any particular case can be easily approximated.

Underground Conduits

There are various forms of conduits employed for carrying pipes underground where isolated buildings are supplied with steam from a central plant. The best type will depend upon circumstances. For high-pressure mains of large size, where the distance is not too great, an arched tunnel of brick or concrete is the best. This should be large enough for a person to pass through easily for purposes of inspection or for repairs. The pipe may be supported by hangers attached to plates embedded in the masonry of the arch, or adjustable brackets may be used, anchor-bolted to the side wall, as shown in Figs. 16 and 17. Mains carried in tunnels of this kind should be protected with a good form of sectional covering, coated with asphaltum or a good waterproof paint.

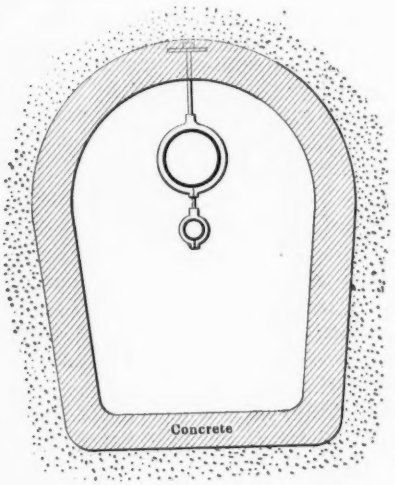


FIG. 16. SUSPENDED HANGER

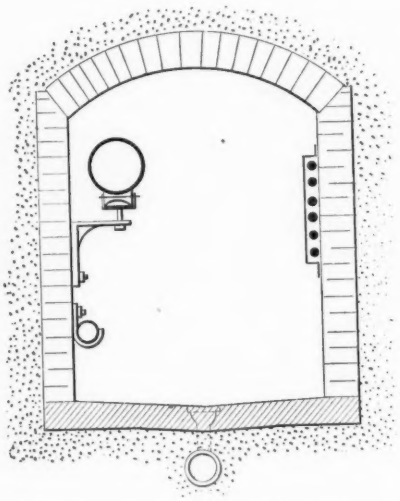


FIG. 17. ADJUSTABLE BRACKETS

A cheaper form of conduit which may be used where the distance would make a tunnel too expensive, is shown in Fig. 18. This consists of a layer of concrete 3 or 4 inches in thickness, with side walls of brick or concrete and a covering of slate or flagstone laid in cement. The pipes are supported upon rolls as shown. When possible a 3- or 4-inch tile under-drain should be provided. This should be laid to a proper grade, have open joints and be surrounded with stones and coarse gravel. Provision must be made at the outlet for carrying away the surface water.

Sectional covering is sometimes used in conduits of this kind, but a better method is to pack the space around the pipe with a mixture of granulated cork and infusorial earth, or with a preparation of asbestos, the latter being considered preferable for high-pressure work.

Another form quite frequently used is the split-tile conduit shown in Fig. 19.

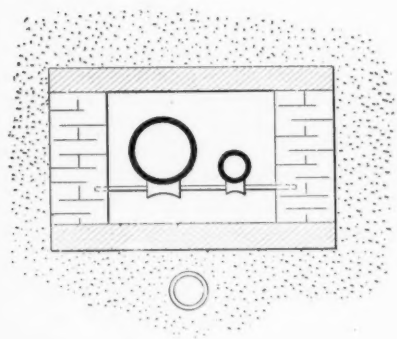


FIG. 18. CHEAP FORM OF CONDUIT

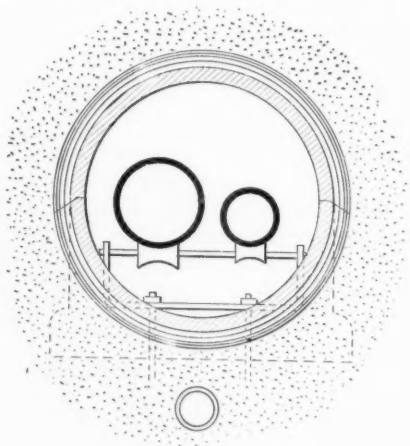


FIG. 19. SPLIT-TILE CONDUIT

The sections are formed with grooves along the sides and may be easily split apart. The lower halves are first laid, after which the pipes are run and the upper halves tightly cemented in place. As each section is completed it is packed with insulating material in the same manner as previously described. The conduit should be surrounded with gravel or coarse sand and under-drained in the manner indicated. This is a patented article, controlled by the H. W. Johns-Manville Company. Conduits of this kind should be large enough to allow an inch or more between the pipes, and about 3 inches between the pipes and walls of the conduit in order to provide sufficient insulation.

Kinetic Energy

By Fred H. Stacey

In reply to queries upon the principles of the injector, it is often stated that the power of the water to enter the boiler against pressure is due to its velocity, imparted to it from the steam while passing through the injector. This velocity gives the water kinetic energy, thus enabling it to overcome the resistance within the boiler and pass through the check valve. It is also stated that the energy of this entering water may be calculated by the formula

$$\frac{W V^2}{64.32},$$

but a more extended explanation is required to make this perfectly clear.

The energy which a body, moving in any direction, is capable of giving up in being brought to rest depends upon its velocity. It is the same as that developed by a body falling from a hight sufficient to give it that velocity. The energy given up by a falling body, as its motion is arrested, is equal to that which was required to raise it to the hight from which it fell. Thus, kinetic energy is the capacity of a moving body to do work. The moment its energy is expended, it is transformed into work, heat or some other form of energy, which is in obedience to the immutable law of the conservation of energy.

The work in foot-pounds required to raise a body vertically through a given distance can easily be found by multiplying the hight in feet by the weight in pounds, and as the energy so expended is returned when the body falls, the energy of a falling body must be the product of its weight and the hight in feet from which it falls.

Other forces, however, besides gravity may give a body kinetic energy. It is, of course, plain that without the action of some force on a body it can have no energy of any kind. If it were not for the force of gravity, a body suspended by a string would have no potential energy, and, if the string were cut, no kinetic energy, for it would not fall or receive motion, and no kinetic energy can exist without motion.

Kinetic energy may be developed in a body moving in a horizontal direction, such as a cannon ball, whose energy is derived from the impulsive force of ex-

ploding gunpowder. As we cannot measure the energy of the ball by the weight and hight from which it falls, except at the instant it touches the ground, we must adopt some other method of computation. If the velocity of the ball is known at any moment of its flight, the energy of the body at that instant can be determined by the formula

$$E = \frac{W V^2}{64.32},$$

in which E = energy in foot-pounds, W = weight in pounds and V = velocity in feet per second. The result of this calculation in foot-pounds will be the same as if the weight of the ball were multiplied by such a hight in feet as it would have to fall in order to gain the velocity noted.

Connection between Velocity and Hight of Fall

To make this clear, an explanation of the connection between the velocity attained and the distance fallen is necessary, and an understanding of the laws which govern the motion of falling bodies will make the matter much simpler. These laws are as follows:

1. A body moving under the influence of gravitation during any interval of time, will gain a velocity, which acting alone, will carry the body twice as far during the next equal interval.

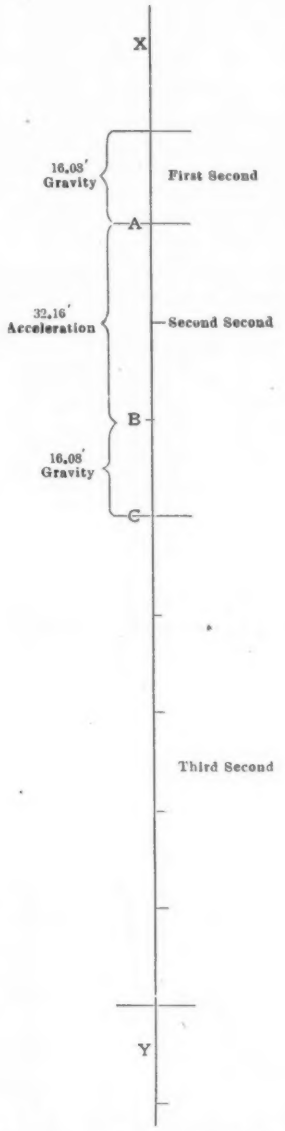
2. Gravitation will add to the motion of a body just as much in every interval of time as it produced in the first.

3. A body falling in a vacuum will move 16.08 feet during the first second of its fall. Applications of the first two laws establish the following: The distance in feet covered by a falling body during any given second of time will be equal to that moved during the preceding second + 32.16 feet. This 32.16 feet is called the acceleration.

These laws have been established and proved by experiment and may be illustrated by the accompanying diagram. Suppose $x\,y$ to be the path of a falling body. During the first second of its fall it drops 16.08 feet to A. During the next second, according to Law 1, its acquired velocity carries it twice as far, or to B, but during this same second, by Law 2, gravity causes it to move an additional 16.08 feet, bringing it to C at the end of the second second.

Next consider what transpires in the third second. In two seconds the body has fallen 64.32 feet. During the next two seconds it would fall, from velocity, 128.64 feet, therefore in one of these seconds (the third of its fall) it moves one-half of 128.64 = 64.32 feet from velocity alone. Add 16.08 feet again for gravity and we get 80.4 feet as the total distance moved in the third second. In the fourth second it will move 6 × 16.08 from velocity and 16.08 from gravity, or 7 × 16.08 = 112.56 feet. Thus we see that the acceleration adds to the motion, 32.16 feet for each second.

It should be borne in mind that these results are accurate only when applied to bodies falling in a vacuum, all bodies, whether light or heavy, falling with the same speed when no air is present to resist motion, but with bodies of fair density the resistance of the air produces only a slight effect and a good approximation is obtained by the use of these values.



VELOCITY UNIFORMLY ACCELERATED

It is now the intention to demonstrate how

$$\frac{W V^2}{64.32} =$$

energy in foot-pounds. We know that $W \times$ distance in feet that the body falls = kinetic energy, and by the formula just given

$$W \times \frac{V^2}{64.32} =$$

the same thing. Therefore,

$$\frac{V^2}{64.32}$$

must equal the hight in feet from which the body falls to gain the velocity V for any particular case. Let H represent this hight in feet, then it may be proved that

$$\frac{V^2}{64.32} = H$$

in the following manner:

Suppose a body weighing 10 pounds to fall from such a hight, or to be propelled forward by such a force as to give it a velocity of 32.16 feet per second. Then by our rule

$$H = \frac{32.16^2}{64.32} = 16.08$$

feet. Referring to the diagram, we see that to acquire a velocity of 32.16 feet per second, the body has to fall for the space of one second, and in that time goes 16.08 feet. Thus H = 16.08 as before, and as $W \times H$ = energy in foot-pounds, this in both cases =

$$10 \times 16.08 = 160.8$$

foot-pounds.

Again, take the velocity at the end of the third second as 96.48 feet per second. Here

$$H = \frac{96.48^2}{64.32} = 144.72$$

feet. By the diagram we can also prove that this is correct. In this case, the kinetic energy found either by

$$W \times \frac{V^2}{64.32}$$

or

$$W \times H = 10 \times 144.72 = 1447.2$$

foot-pounds.

The relation can be proved in a similar manner for any velocity or value of H.

It will be noticed in the formula that 64.32 equals twice the acceleration. This constant can only be used in connection with the force of gravity, other forces requiring different constants, according as their power is greater or less.

Fighting frazil ice has been carried on in some Canadian water-power plants so successfully as to keep the wheels running all the winter by employing heating apparatus, and by a construction which excludes the cold winter air from all parts of the plant. Frazil will not adhere to metal unless the latter is below freezing temperature, and heating devices have been arranged to warm the racks and controlling gates, the parts most frequently clogged, and thus keep them free. The last winter was the first in which the plant of the Ottawa Electric Railway Company made use of heat in fighting frazil, with the result that this was the first winter in which the company had not had to chop ice out of the wheels by hand.

The Plunger Hydraulic Elevator

Construction and Operation of Main and Pilot Control Valves; Comparison of Different Control and Automatic Stop Valves

BY WILLIAM BAXTER, JR.

The general arrangement of the main valve and pilot, the automatic stop valves, the actuating ropes, etc., of the latest type of Otis passenger plunger elevators is shown in the vertical elevation, Fig. 260. This drawing is made to scale, and shows all the parts in their true proportion. The reference letters are the same as in Fig. 245, so that the difference between the two arrangements, as well as the difference in the design of the valves, can be easily distinguished. The automatic stop valves *A* and *B* are of the design shown in Fig. 258 and the main valve is the type shown in Fig. 253. The flow of water through the entire system is indicated by the arrows. When the valve is set to ascend, water flows in from the supply pipe through the stop valve *A* to the inlet at the right-hand end of the upper cylinder of the main valve. Passing through the valve the water enters the vertical pipe leading from the central outlet of the valve chamber, enters the upper end of the lifting cylinder, and forces the plunger upward, thus lifting the car. When the valve is set to come down, the water in the lifting cylinder flows out and down through the vertical pipe to the center of the valve chamber, through the valve to the left side outlet, and thence through the pipe to and through the stop valve *B*. In Fig. 245 the two automatic stop valves are made so that the water flows through them from top to bottom, but in Fig. 260 the water enters both valves at the bottom and passes out at the top.

The levers of the valves *A* and B are arranged as in Fig. 258. The rope that actuates the valve *A* runs over and under the pair of sheaves shown just under the floor of the elevator pit. This arrangement is shown in order to be able to give a slide view of the lever *A'* and the rope *A"*; in practice the lever *A'* would be rotated around far enough to permit the rope to run up in a straight line back of the elevator car. The upper end of the rope *A"* is secured to one of the overhead beams, as shown in Fig. 261, which shows the top of the elevator well, with the overhead sheave over which the counter-balance ropes run, and also the arrangement for holding the upper ends of the pilot valve operating ropes. The rope *B"*, that actuates the lever *B'* of the valve *B*, runs up and over a stationary sheave and thence under a sheave attached under the car, near the right-hand side. In this case the stationary sheave is necessary to prevent the rope from pulling sidewise on the lever *B'* when the car approaches the bottom floor. The rope *B"* is secured to the overhead beams at one side, as shown in Fig. 261.

The pilot valve is actuated by the ropes *G' G"*, one side of which is secured to

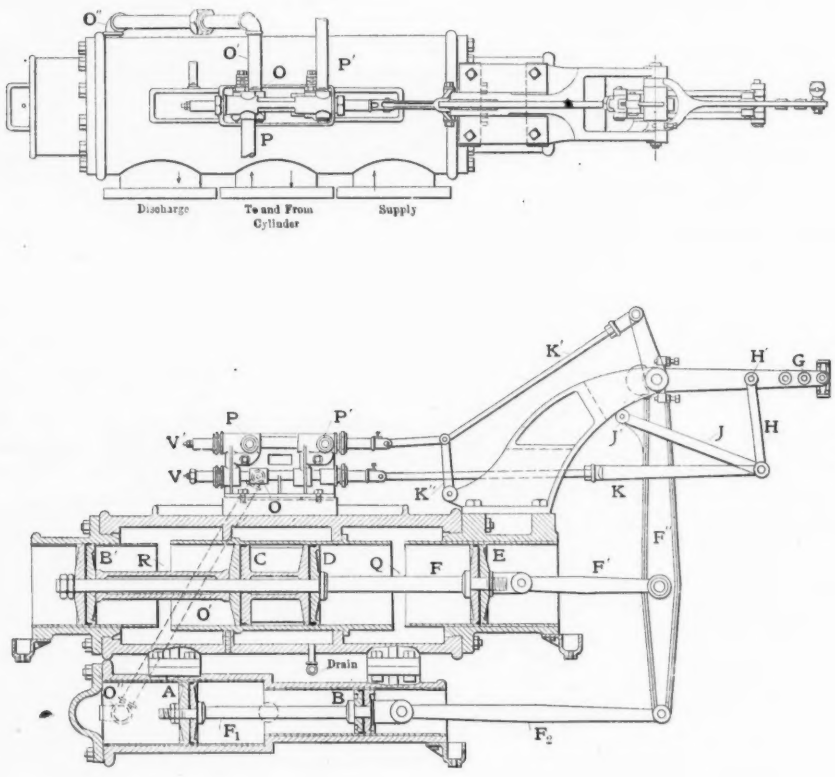


FIG. 253

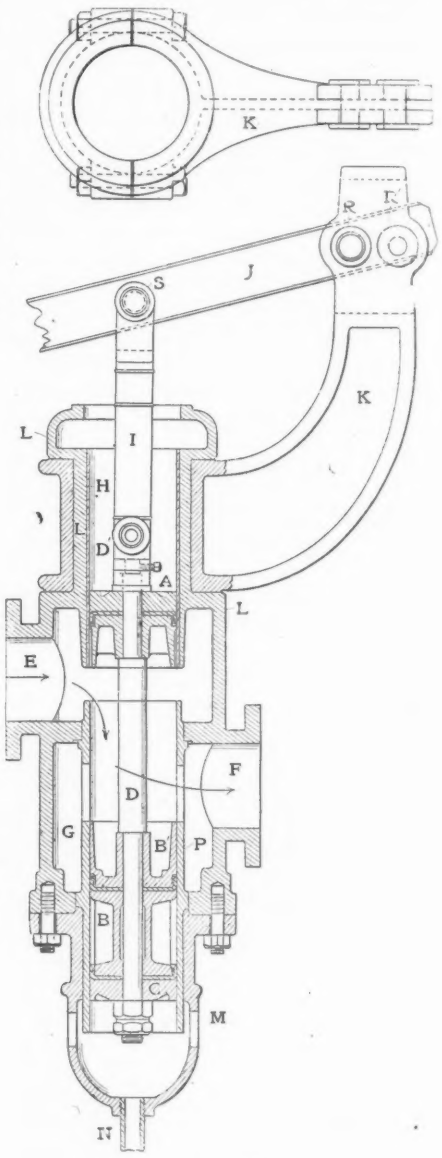


FIG. 258

the end of the operating lever *G*. This arrangement is of the standing-rope class, which was fully explained in previous articles, but it is slightly modified, the modification being necessary by reason of the fact that the lower supporting sheaves *H* cannot be run down below the lever *G*, on account of the space being taken up by the valves and piping. The stretches of rope *G'* and *G''* are a single continuous rope, the two ends of which are secured at the top of the elevator well to a tightening lever *N*, as shown in Fig. 261, the weight *W* being set to put the proper tension on the ropes. Coming down to the car, Fig. 260, these ropes pass around the two sheaves *S*, *S'* carried in a frame *M* mounted upon the car and connected with the car lever *L* through the rod *L''*. The rope *G'* runs under the sheave *S'* and over the sheave *S*, thence down to the lever *G*, and passes under the sheave *H''* located below the lever *G*. This part of the apparatus is more fully shown in Fig. 262, which is a side view of the lower part of Fig. 260. Passing up from the right side of the sheave *H''*, the rope becomes *G''*, and upon reaching the sheaves *H*, passes over the one on the right-hand side and under the one on the left, and then runs up and over the sheave *S'* and under the sheave *S*, thence up the elevator well to the tension lever *N*, Fig. 261.

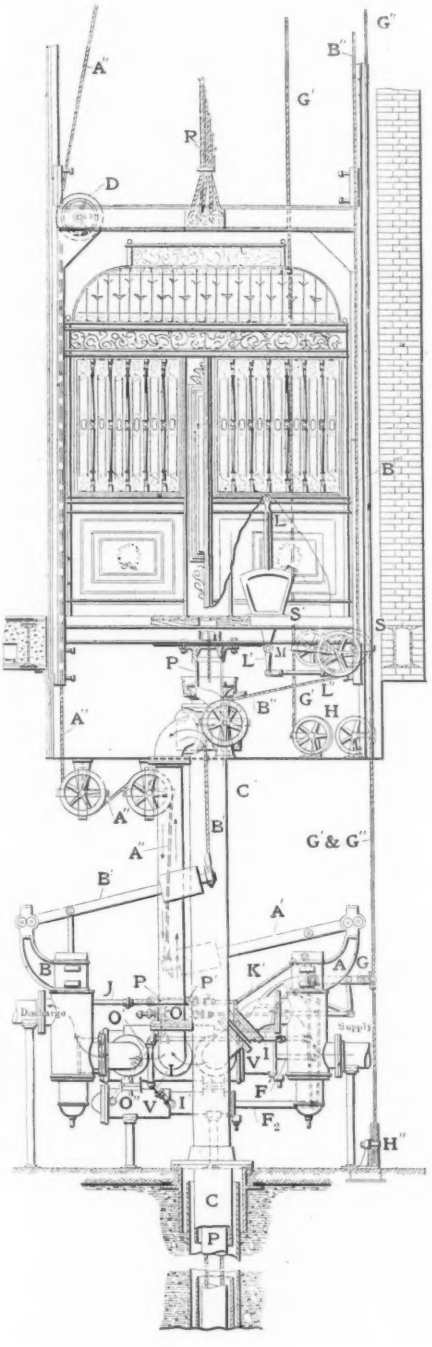


FIG. 260

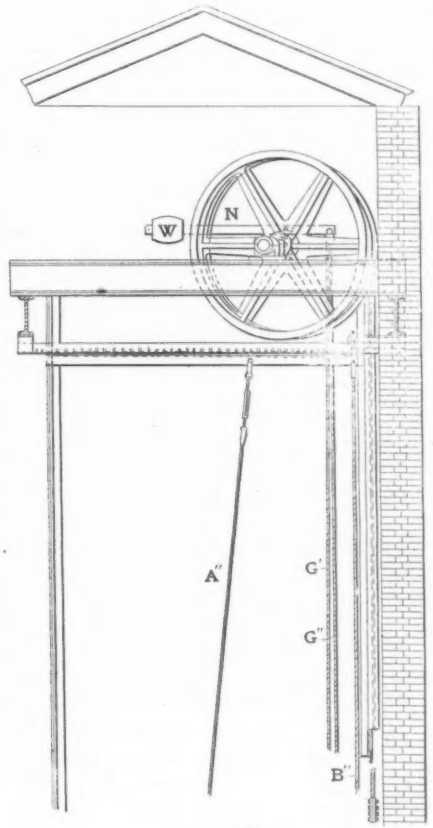


FIG. 261

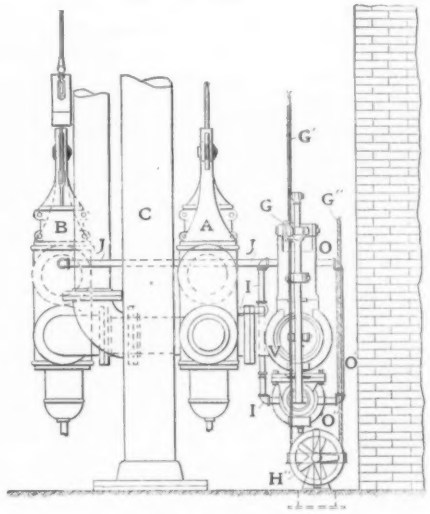


FIG. 262

Keeping in mind the arrangement of the ropes just described, it can be seen that if the car lever *L* is moved to the right, the connecting rod *L''* will move to the left, and swing the frame *M* clockwise, so that the sheave *S* will move downward and *S'* upward. As the rope *G''* passes over the sheave *S'* it will be drawn up and *G'*, which passes under *S'*, will be let out, the result being that the pilot-valve lever *G* will be raised. The sheave *H''* and the extension of the ropes below *H* complicate the arrangement slightly, but do not change the principle of operation in the least.

In Defense of the Gas Producer

By Frank P. Peterson

In the face of the vast mass of vacillating evidence going the rounds, it would be unwise to predict with any degree of assurance with reference to the small gas producer; but there is a persistent idea in the writer's mind to the effect that the small producer, as at present employed, is nearing a stage in which it may be presently recognized, or measured, by some set lines of standards. Also there will be a sense of recognition that will respect its limitations and flexibilities to that degree which a well designed and honestly rated producer merits.

With a very few exceptions those builders who experienced early difficulties (and exceptions to this class are very scarce), have accounted for and corrected, in the main, these difficulties, so that we may safely assume that a majority of those who offer for sale such power-plant equipment are prepared to substantiate with service the claims they make for their apparatus.

Many builders of producers are prepared to supply their own make of engine for which they should have thoroughly established records of performance, and there remains positively no excuse for unverified or over-sanguine representations to the prospective buyer; which means that we may look to the present types and general forms of producers as having become sufficiently established to remain with us for a while. In this statement it is desired to refer directly to anthracite producers in unit sizes ranging from 25 to 300 horsepower capacity, as commonly designated. Therefore, lines drawn as means or averages of this practice will become the standards by which the producer may be gaged.

It then occurs that the wonder workers and the great discoverers of new scientific principles, and the rescuers of the industry from utter failure and complete miscarriage, might sit down and take a rest.

Early Designs

A few remarks in review of the general disposition which has been made of the original ventures and the products resulting from initial designs of American producers, and the corrective measures employed by those who rose early in order to try to "catch the worm," may be of interest before we pass to a consideration of what exists. Those initial designs were based upon, and in most instances were close copies of, apparatus which had already shown effectual results, so far as could be learned, in Germany, France and England; this after diligent investigation and inquiry. In plain terms, the would-be producer manufacturer thought he had made sure that he was right and then had gone ahead in the serenest of confidence. And when he found that he was not right, the awakening came, not with a shocking realization of some wide and readily recognizable error, as we might too quickly conclude, but with a slowly accumulating conviction that was stunning in its effects. Why? Because when he sought those who were pointed out as authorities on the subject, they led him directly away from the real source of his greater measure of difficulty; pointed his nose into a fruitless search for a hundred and one faults and defects, chiefly structural and operative, that were in evidence in the general debility from which the apparatus suffered. Any one of these may have been responsible for a part of the mischief that was going on, yet none of them, in most instances, would have accounted for serious deficiency in a healthy producer.

Of these many suggested defects, first and most frequently came linings and leaks, and so much was made of faulty linings and defective bricks and settings that the producer man became afraid to look a firebrick in the face, so to speak. Lining after lining was ripped out and replaced with new, only to the end that results preceding the work were repeated following it, as soon as the apparatus was heated up thoroughly and reached a normal state of service. A careful inspection of these linings during removal showed no indications whatever, in most instances, of poor setting or possible short-circuiting of the gas through them, but we were dealing with an unknown quantity in a new problem, and what might not "suction gas" do, anyhow? So, with the extremest vigilance, linings of new material were reset, and then the leak phantom was chased. Candles became too crude, and soap suds were resorted to, and the tiniest little leak discovered was pounced upon and suppressed with a vengeance which need not have been misapplied to a more valient foe.

Fuel was picked and selected and condemned and rejected, and operators were instructed in the minutest details and cautioned against failure to perform the strictest measure of conscientious duty. Fires were withdrawn once a week or oftener; they are yet in lots of installations of the old order, with all the attendant dust and heat and waste of fuel and breaking of patience. Nothing is more enjoyable to the ambitious young man than to tickle down and wet out a couple of tons of glowing hot anthracite coal in some close cellar corner on a hot summer Saturday afternoon when he knows there is a ball game progressing at the park.

And then follows the delicate operation of cutting solid slag loose from the firebrick and leaving the bricks so sound and solid in their settings that no leakage can occur; squeezing through doors of exceedingly limited opening, or charging hopper throats, into veritable craters of rasping, cutting dust, to reach and prosecute the work—serious responsibility coupled with the most disagreeable labor. No wonder the producer was given a dirty turn in some instances. The prospective operator who happened to have some previous knowledge of such conditions as prevailed in many instances had good reason to look with disfavor upon the coming producer.

Then the matter of dirt and impurities came in for a large share of investigation and elimination. And areas of passages and connections and the internal contour of the plant in general were given all and sufficient consideration, with a wholesome fear of eddy currents and excessive resistances and all that might attend.

Mixing devices were prodigiously studied and supplied at the engine. Then, in due course, arose the importance of proportionating the steam supply properly in the producer draft, and, finally, the detriment of steam in any proportion. Harnessing the gas and delivering it under pressure to the engine at any expense and complication was resorted to, strange to say, in plants of such ample working area as to suffer no such requirement.

And they drifted, through all this, inch by inch, directly against the counsel and warning of some of these "recognized authorities" who spoke loudest, into larger and more liberal working areas of fuel. By the sheer force of a slow process of evolution, rather than by a bold step, the most of the builders have groped their way to a stage that places the producer on a level of reliability to be respected and seriously considered by all concerned.

What the Authorities Say

Just here let us note a few references to authority in this matter of relative working area and capacity of small producers. Only the most striking of these published discussions which it has been the writer's privilege to mark will be cited for the sake of the general interest which may be felt in a subject which has been recently handled by writers of undoubted ability to no inconsiderable extent.

The most recent and a quite comprehensive venture into gas-producer text work gives as a basis for safe design an area of about 0.055 square foot of producer area per rated brake horsepower of engine. Some other accepted authorities, in works relating to the subject, have carefully avoided specific statements outlining the values of working zone areas against equivalent measures of power in engines dependent upon those areas to supply gas. This will appear to be a perfectly consistent and at least an effective means of avoiding the very considerable amount of discussion that could even generalize with the widely varying classes of fuel and conditions to be met. Not all, however, have been thus careful. Well along back toward the beginning of the excitement a widely read little work, "published with a view of supplying the demand for information on the design, operation, cost of running, etc.," presents some statements from which I quote the following:

"A ship-boiler furnace with forced draft burns easily 31 pounds of coal for each square foot of grate surface. As each pound of coal develops about 64 cubic feet of gas, one square foot of grate area would supply at least $31 \times 64 = 1984$ cubic feet of gas. The average consumption of gas is 105 cubic feet per actual horsepower hour. Consequently, the above amount would suffice for $1984 \div 105 = 19$ brake horsepower (nearly) and for each brake horsepower 1/19 or 0.053 square foot would be required. In fact, this figure coincides pretty well with those calculated from approved plants that possess from 0.048 to 0.064 square foot of grate area for each horsepower if anthracite is used, while for coke about 0.085 square foot is provided."

With dimensions derived from the statements of this writer, and for the sake of a comparison with a case in mind and which it is desirable to refer to a little farther on, let us see what a practical application would show. Taking the maximum allowance set forth, 0.064 square foot, we should have, for a 175-horsepower producer a working zone area of 11.2 square feet, or a diameter of nearly 3 feet 4½ inches. As a matter of fact, it is possible to point out producers in operation to this day, with our fuels and our conditions (meaning our engines and our knowledge and development of the industry), dimensioned and rated within the limits set by the assumption above taken.

A still more extensive work by a probably more widely accepted authority, which reached practically every man concerned with the subject, presented the following assumptions for the dimensions, "to be given to the generator relative to those of the engine to be supplied, upon the assumption that the engine is to be single acting and runs at a normal speed of from 160 to 230 revolutions per minute." Without further reference to

piston speed, or displacement in unit volume against time, it is stated that the cross-sectional area of the working zone of the generator should be from one-half to one-fourth, "and sometimes between one-half and nine-tenths of this surface" (presumably the surface area of the engine piston head or face) "according to the nature and size of the fuel used." And a little farther: "It is to be noted that most modern generators are rather too large than otherwise." * * * * * "Many manufacturers of no wide experience have been led to make their apparatus rather large so as to insure a more plentiful production of gas. As a matter of fact, the fire in such apparatus is liable to be extinguished when the combustion is not very active."

With reference to those statements vital to design, they certainly cannot apply in any sense or relation to even the best obtainable American fuels or records of performance of engines and producers available either prior to or since the presentation of the work. Nor have I been able to note any comment or criticism which might have presented to the seeker of such information a rational or applicable interpretation of the discussion as it stands, yet unrevised, so far as he knows.

If, now, we take the case of a highly efficient engine, of the performance of which the writer has personal knowledge, a comparison will be interesting because of its absurd novelty. This engine has a piston area in each of two cylinders of 1.417 square feet, or a total for the two cylinders of 2.834 square feet, and the engine developed 175 brake horsepower within the speed called for by the author's statement quoted. If we take his maximum allowance of nine-tenths of the area of piston surface, we shall have a working zone area of 2.5506 square feet, or a net fuel-chamber diameter of 21⅝ inches for a 175-horsepower producer!

Is it, then, any wonder that builders of gas producers may have been somewhat tardy in arriving at conservative ratings and is it not somewhat surprising that there has not been a sufficient common interest to bring together some definitely conclusive evidence establishing a safe rating?

A Horizontal Engine with Vertical Shaft

By Edward T. Binns

A horizontal engine with a vertical shaft is in itself a rather interesting departure from the general form and design of reciprocating engines. The engine described herewith has been brought out to meet the increasing demand for a power to act directly upon vertical shafting. It is particularly well adapted to driving vertical, centrifugal and turbine pumps as auxiliaries to condensing plants. The arrangement of the engine admits of direct connection by extending the crank shaft to any distance above or below. The flywheel or balance wheel is mounted upon a pedestal base in the center of the crank case, and the moving element rotates upon a thrust bearing made in three different ways. For the smaller sizes, marine and fiber bearings are used, and ball and roller bearings for the larger engines. The top bearing, or outboard bearing so to speak, having no weight to carry, is held in place by a spider suspended for the purpose diagonally across the crank case. The engines are of the center-crank type, and their construction is readily apparent in the cross-sectional view.

The flywheel is attached to one of the cheek pieces of the crank, the bottom face of which forms the seat for the thrust bearing. The valve gear is driven from an ordinary eccentric upon the upper end of the crank shaft, and the motion of the eccentric is at an angle of 45 degrees with the plane of the valve travel. To transfer the motion from the eccentric to the valve as required, a universal joint is placed on each end of the valve-eccentric rod. The crosshead is provided with three guides and shoes, the two side guides being the regular working guides,

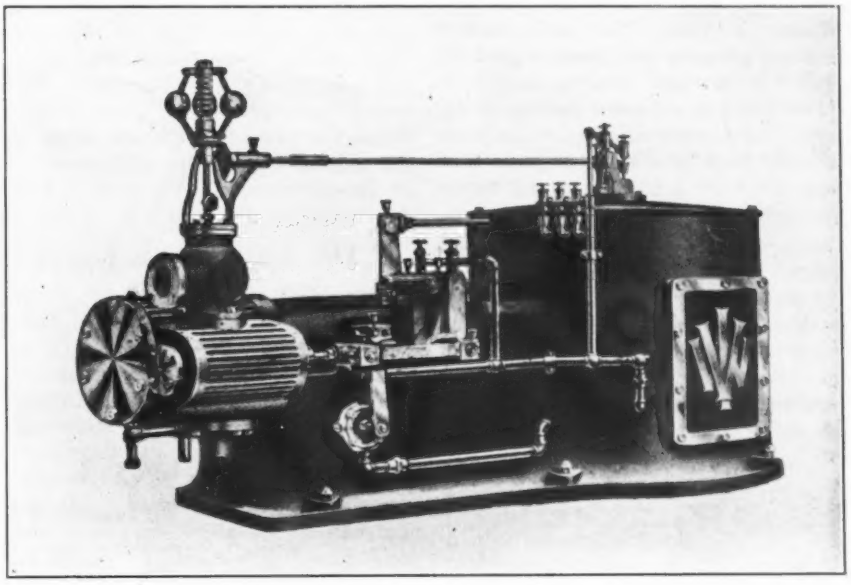


FIG. 1. LYCOMING VERTICAL-SHAFT ENGINE

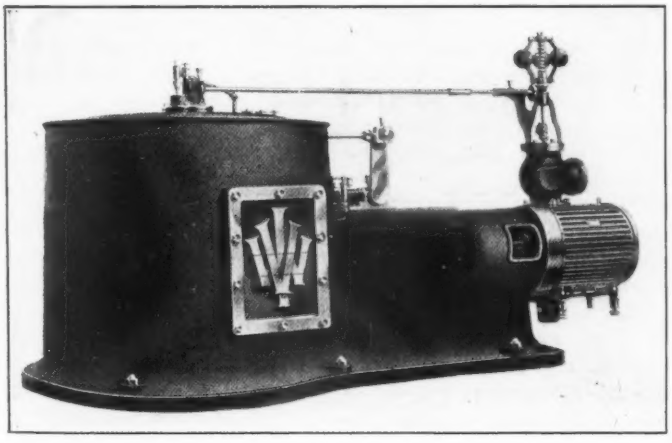


FIG. 2. REAR VIEW

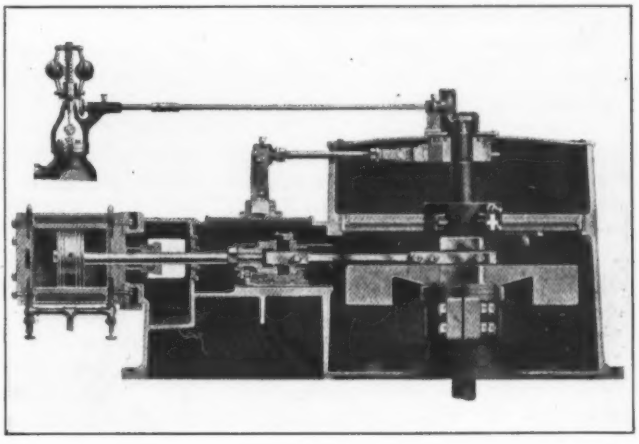


FIG. 3. SECTIONAL VIEW

while the bottom one carries the weight of the crosshead and preserves the proper alinement of the engine. All are adjustable for wear.

These engines are fitted with either automatic or throttling governors, as occasion requires. Where a uniform speed is to be maintained, the automatic governor is used, being attached to the crank shaft above the top bearing, to play upon the throw of the eccentric. Where the conditions require that a change of speed must sometimes be made while the engine is in motion, in large condensing installations for instance, the throttling governor is used. The new Gardner throttling governor has been adopted. It admits of 100 per cent. variation, and can be manipulated while running at any speed. These governors are driven from the main shaft by a small diagonal shaft fitted with miter and bevel gearing for the purpose.

The crank case is inclosed, and presents a neat, compact appearance. It also acts as a reservoir for the oil used, which is circulated continuously over the bearings by a small pump attached to the bedplate and driven from the rocker arm. The crank pin is oiled from a hole in the shaft.

A rather ingenius plan is adapted to prevent the oil from following the shaft below the engine, a clear idea of which can be obtained from the accompanying sectional drawing. There is an opening in the bottom of the base upon which the balance wheel rests. In this space revolves the oil collar which is rigidly attached to the shaft. The rim of the collar is drawn out to a thin edge, so that centrifugal force throws the oil off into a circular cavity provided to receive it. From this cavity it is carried by small pipes to the main reservoir in the bedplate.

Access to the inclosed parts is had by doors, which for the sake of appearance, are nickel mounted. The one opposite the balance wheel is provided with a small self-closing opening to admit a bar for moving the engine by hand when necessary.

The engine is manufactured by the Valley Iron Works, of Williamsport, Penn., which company has for years built the "Lycoming" engine. It would appear that the vertical-shaft engine has a wide field of usefulness.

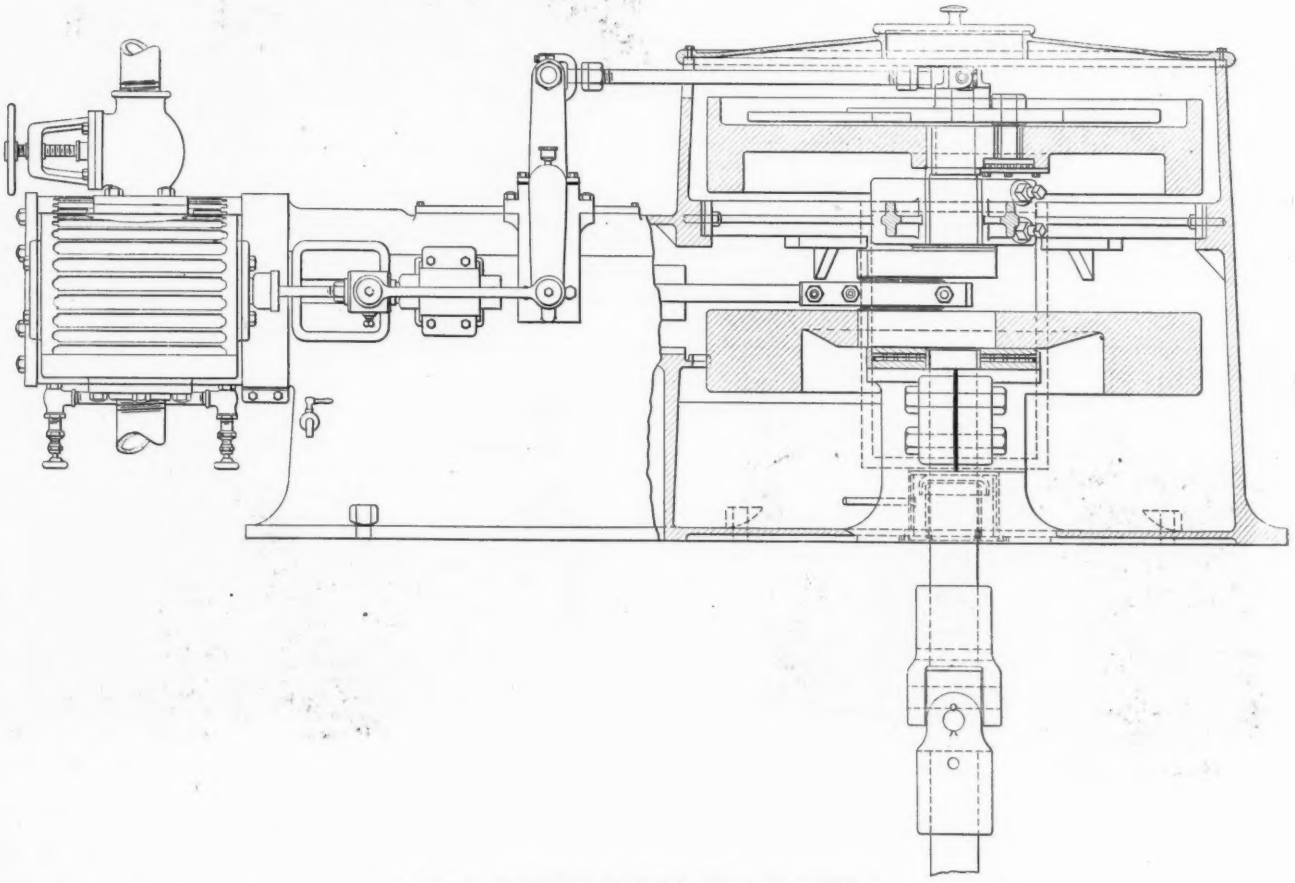


FIG. 4. SECTIONAL DRAWING OMITTING GOVERNOR

The Action of the Injector

By W. H. Booth

A flood of mathematics has been expended on the injector in explanation of what to some is its curious action. The injector is a heat engine and can be properly explained only by the use of mathematics; but many who do not read mathematics with ease, would undoubtedly like an explanation in terms of things stated as they understand them. To begin with, therefore, let us take the exhaust-steam injector, because exhaust steam is such poor stuff that it may well cause a few minutes' wonder as to how at zero-gage pressure it can force water into a boiler under 75 pounds gage pressure. It may be allowed that exhaust steam will flow into a fair vacuum at a velocity of 1200 feet per second, and it will carry with it, say, four times its weight of water.

In the first place, when two bodies are in motion and join forces, they continue to move forward at the average velocity. There is no change in momentum. Thus, if we have a pound of steam moving 1200 feet per second and four pounds of water at, let us say, no initial velocity, the net result will be a combined stream of five pounds at a velocity of

$$\frac{1200}{5} = 240$$

feet per second. There is a formula for the velocity of flow of water due to a hight of so many feet of fall. The formula is

$$V = \sqrt{2gh};$$

where

V = Velocity in feet per second,
g = Gravity = 32.2, and
h = Head in feet of water supply.

It is approximately correct to write

$$V = 8\sqrt{h}$$

for $2g = 64.4$, which is very closely 8×8.

The velocity V has already been given as 240 feet per second, so that if this value is substituted in the formula in place of V, we get

$$240 = 8\sqrt{h},$$

$$\sqrt{h} = \frac{240}{8} = 30,$$

$$h = 900.$$

Thus to gain a velocity of 240 feet per second, the pressure will be that of 900 feet of water. Since a foot of water represents 0.43 pound pressure, h would be equal to 387 pounds per square inch, that is to say, that if the full velocity of the combined jet were secured, it would enter a boiler at 387 pounds pressure.

Let us, therefore, make a second trial and assume each pound of steam to carry seven pounds of water. Then the velocity would be

$$\frac{1200}{8} = 150$$

feet per second, and again employing the formula for velocity, we get

$$V = 150 = 8\sqrt{h},$$

$$\sqrt{h} = \frac{150}{8} = 19$$

nearly, so that

$$h = 19^2 = 360$$

nearly, and

$$360 \times 0.43 = 155$$

pounds pressure. So far, then, it is easy to see that with the assumptions made, the entry into the boiler may be very easily effected. Are the assumptions possible and probable?

If we start with the feed water at 60 degrees Fahrenheit, and it enters the boiler at 190 degrees Fahrenheit, which we know to be possible, the water gains 130 B.t.u. per pound. The steam falls from 212 to 190 degrees, and loses in all about 970 B.t.u., or over seven times as much as the water gains, so that the last assumption of 7 to 1 should not be far wrong. What the exhaust injector actually does do cannot here be stated, but the fact remains that it is not neecssary to assume that the whole of the steam is condensed, for there is considerable difference between a pressure of 155 pounds and the 75 pounds pressure in the boiler.

By careful manipulation the exhaust injector has carried water into a boiler carrying a pressure at considerably above 75 pounds; but like all other instruments it suffers internal losses from friction, eddy currents, and so on. In order to make it act, it is necessary to start it with a free overflow, and this was first obtained by means of a split nozzle. The loose half of the nozzle hung on a hinge pin, and would automatically swing free from the face of the fixed half of the nozzle. When the jet was established, the hinged piece was closed by the vacuum, and if from any cause the jet broke, the nozzle promptly opened and let the combined stream overflow again. The jet then gradually reformed and acquired momentum and direction, so that the instrument was automatic.

It may be supposed that the velocity of flow of 1200 feet per second previously given is too high, owing to small pipes, bends in pipe, and the small degree of vacuum. Even if taken at only 800 feet per second and the combined jet has a velocity of only 100 feet per second, the injector would appear capable of working against a head of

$$\overline{12.5}^2 = 156$$

feet, or 67 pounds. Thus, however looked at, the working of an exhaust injector seems to be explicable from any ordinary reasoning. We have got to forget that the steam is exhaust steam at zero pressure. It has a pressure of 14.7 pounds absolute and a large heat value, and its action is purely kinetic, that is to say, it works because its molecules, being hot, have the power to move, and will flow rapidly into a partial vacuum. On this question more might be said, but the point to be remembered is, that a gas which will condense may be made to do work, because the condensation produces a partial vacuum or place of lower pressure, and into this space steam will flow continuously at high velocity, creating in the case of the injector sufficient energy to force the water into the boiler.

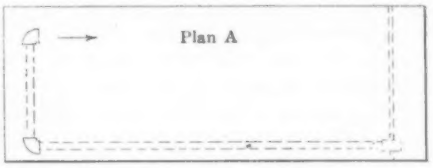
Boiler Feed Pipe Terminations

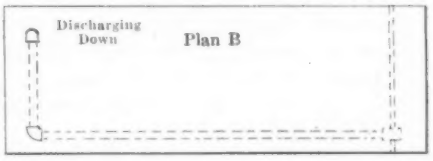
By E. L. Hill

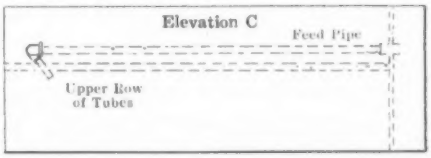
The boiler house referred to herein contained eighteen 72-inch by 21.5-foot horizontal return-tubular boilers, each containing about 1800 square feet of heating surface. All of the boilers showed more or less tendency to develop fire cracks or leaks, or both, at the first seam and with no very apparent reason. An investigation revealed the fact that the feed-water pressure was somewhat higher than need be, and that the terminations of the feed pipes inside the boilers consisted of elbows discharging horizontally forward as shown in the diagram marked *A*. The next step of the inquiry was to make one boiler tight, fill it with water and get up steam, during which operation frequent inspections of the first seam showed no trace of leaks. Then the boiler was put into the main line, and after a short while, when it became necessary to raise the water level, the first seam was again kept under observation as the feed valve was opened. Almost immediately the seam began to leak slightly, and here was the cause: The water entering the boiler at a pressure considerably higher than the steam pressure, evidently reached the forward end of the boiler and, being comparatively cold, sank right down on the hot shell, thus starting the leaks.

To remedy this, the elbow on the end of the feed pipe was unscrewed a quarter of a revolution and left so that it would discharge vertically downward, as in sketch *B*. This change eliminated practically all the trouble which had been caused by the other arrangement.

On another battery of boilers, the feed pipe terminated in an elbow, at a point shown by sketch *C*, which discharged downward and forward at an angle of about 45 degrees, and into which a nipple about 12 inches long was inserted. Although the feed pipe entered the boiler about 3 inches above the upper row of tubes, and continued along at that hight above them, the end of the nipple was a few inches under the surface of the water,







VARYING ARRANGEMENT OF FEED PIPE

and below the top row of tubes. This arrangement was installed by the boiler-makers when the boilers were set up and gave very little trouble from leaks or fire cracks, but proved to have one serious defect. Owing to an unavoidable accident, the feed pipe to one of the boilers became broken, and before the boiler could be shut off from the main line or the fire banked sufficiently, the water level had been drawn below the upper tubes, the check valve not seating tightly, by the steam pressure forcing the water up through the nipple and out of the feed pipe through the break, and thus allowing some of the tubes to be badly burned. After this experience, the nipples in all the other boilers were removed and the elbows turned so as to discharge straight down, as this position appears to give better results and less trouble than any other.

Practical Letters from Practical Men

Don't Bother About the Style, but Write Just What You Think, Know or Want to Know About Your Work, and Help Each Other

WE PAY FOR USEFUL IDEAS

Failure of a Cross Compound Engine

In the issue of July 28, De Witt Pourie writes on the subject of compound engines under the above heading. The title would lead one to expect an account of the failure of a certain engine, but it seems that he and Mr. Wakeman have discovered that *all* cross-compound engines are failures; and worse still, it must necessarily follow that compound engines of all kinds are also failures.

This is rather hard on the mill owners who have supposed they were doubling their power by using their simple engines as the high-pressure elements of cross-compound engines.

Mr. Wakeman qualifies his statement by assuming that the simple engine cylinder is used as the high-pressure cylinder. If he assumes that this is done without any change in pressure, he is simply setting up a man of straw and knocking him down, for no engine designer ever thought of doing such a thing.

A steam-engine builder designs the reciprocating parts and the bearings and frame of his engine to safely transmit a certain power from the piston to the shaft, and then selects a cylinder of the right size for developing this power under the conditions of pressure which are to prevail. The practical horsepower of an engine is, therefore, not determined by the pressure that may be delivered to the piston, but by the ability of the engine structure and bearings to transmit power to the shaft. In other words, it would be a disastrous failure to try to double the power of an engine by increasing the steam pressure or the cylinder diameter.

When it is desired to double the power of a simple engine by making it the high-pressure side of a cross-compound engine, the order of procedure is as follows:

A duplicate engine is connected to the outer end of the shaft and is provided with the low-pressure cylinder. This new frame with its bearings and reciprocating parts has the same capacity to transmit power safely as the original simple engine, and the two have, therefore, a safe capacity for double the power of the original engine.

It only remains now to select cylinders which, under the available pressure, will develop the desired power at desirable points of cutoff. Ordinarily, the original simple engine cylinder will be too small, and a larger one must be substituted.

It sometimes happens, however, that the pressure may be somewhat increased and a condenser connected to the low-pressure cylinder, in which case the simple engine cylinder may have enough capacity and no change is necessary.

Mr. Pourie refers to the "angle-compound" engine, and thinks somebody must be mistaken about doubling the power for a given floor space by combining a vertical low-pressure engine with a horizontal high-pressure engine of the same power.

This is exactly and literally what is done, for the high-pressure part of the engine corresponds exactly in its structure and reciprocating parts with a simple engine with half the power of the angle-compound, and the vertical structure has reciprocating parts of the same capacity. Both cylinders are selected with a view to developing the normal power for both sets of reciprocating parts, and the total power is, therefore, double the power that would be safely transmitted to the shaft by the horizontal part of the engine if used as a simple engine.

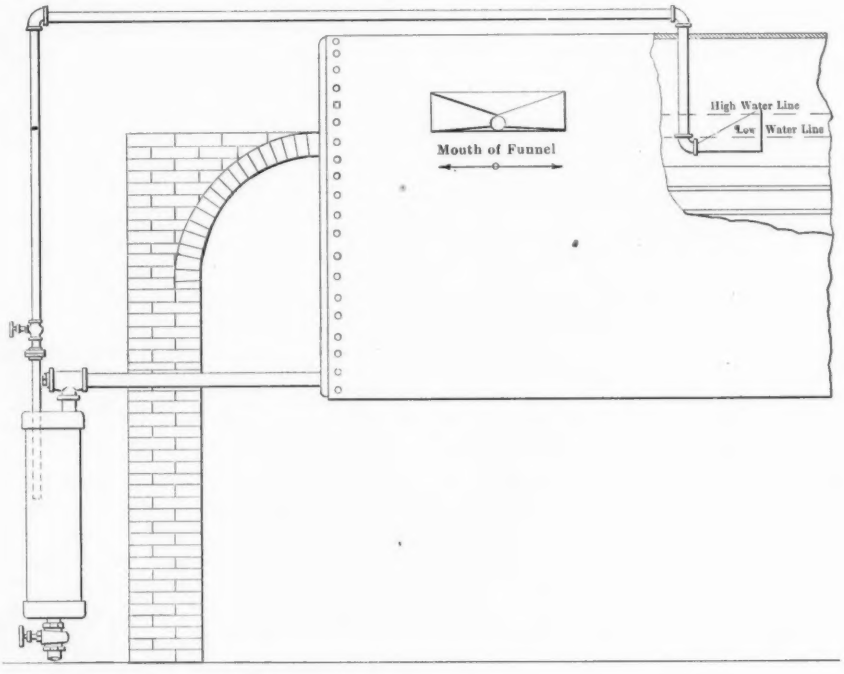
It would appear, therefore, that Mr. Pourie must guess again about compound engines.

F. H. Ball.

Bound Brook, N. J.

Suggested Improvement for Mr. Barrho's Blow-off Arrangement

In the July 28 issue, J. Barrho shows a good blowoff outfit and the following is given as a suggestion for improving and simplifying it. In the first place, Mr. Barrho's funnel is not of the correct shape, as it should have a rectangular mouth with the bottom level, or parallel with the surface of the water. The top of the nipple in the back of the funnel should be placed ½ inch below the lowest water line, and the top of the funnel should project 1 inch above the highest level of water when running. Unless the funnel nipple is constantly submerged the circulation will not be steady. The size of the nipple in the funnel should govern the size of the pipe all the way to the precipitator, 1¼ inches being best for boilers up to 150 horsepower. The funnel should be placed one-third the length of the boiler from the rear head. That is,



IMPROVEMENT FOR BLOW-OFF ARRANGEMENT

if the boiler is 15 feet long, the proper location will be 5 feet from the rear end.

If he will set his skimmer as shown in the accompanying sketch he can do away with the 2-inch bypass around the precipitator which he opens once a week. The arrangement as shown in his sketch must carry a great deal of sediment back to the boiler through the blowoff pipe. The pipe from the skimmer should run down about halfway into the interior of the precipitator. This will assist the sediment in maintaining a downward curve. I would also advise the use of two valves on the blowoff under the precipitator, as it is impossible to keep one tight.

In blowing off, open the top valve first, then the lower one; when done blowing, close the lower valve first, then the top one. If this course is followed, the top valve is not subjected to the wire drawing which is so destructive. The precipitator will do better if a little larger, say 10 by 42 inches.

No fixed time has ever been found for blowing off, but it should be done whenever the lower end of the precipitator gets cool enough to bear the hand without burning. If the lower end does not cool down in two or three hours the circulation is not going on properly. Mr. Barrho can move his funnel forward without cutting another hole in the boiler by running a horizontal pipe from the lower ell.

GEORGE R. WILLIAMS.

Findlay, O.

Steam Loop Trouble

On page 279 of the August 18 issue, I note a question by F. H. Beard. He refers to a drawing illustrating what he calls a "steam loop." His idea probably is that the steam will rise to the top of the vertical pipe after passing through the radiator before condensation takes place, and that the weight of the water on the return will carry it into the boiler through the blow-off pipe.

In the first place it is very bad practice to place an arrangement of piping so that water circulates through the blow-off pipe, which should have a connection devoted to that purpose alone. A circulation in this connection keeps the mud away from this part of the boiler and it is the mud which the blow-off is supposed to carry away.

The reason that the device does not work, however, lies in the well known fact that water always seeks its own level. There is no way of making such a system as Mr. Beard illustrates work without the aid of a pump. Water from condensation will collect in the lower radiator and its piping until it is level with the water in the boiler and there will be absolutely no circulation. Of course, if there was an elaborate system of drainage and the drop in temperatures could be exactly figured out, it might be possible to construct such a loop that the weight of the water on the boiler side of the device would overbalance the weight of the steam on the other side. But even then, water-hammer would make it impractical.

L. F. WILSON.

Chicago. Ill.

I wish to offer the following probable cause of the failure of Mr. Beard's steam loop to operate successfully, and submit the accompanying suggestions:

The action of a steam loop of this description is as follows: The pressure in the heating coils and riser is somewhat less than at the boiler. The boiler pressure is given as 90 pounds per square inch. Say, for example, the drop of pressure through the coils and riser is 6 pounds per square inch. This would leave a pressure of $90 - 6 = 84$ pounds in the riser. This pressure of 84 pounds extends back through the loop, lifting small slugs of steam vapor and water over the return-bend at the top of the riser. The steam is condensed in the horizontal pipe, due to the cooler atmosphere surrounding it, thereby creating a partial vacuum in the loop, and decreasing the pressure in the horizontal and riser.

The column of mixed steam vapor and water in the riser being much lighter than the column of water in the drop-leg rises over the return bend to take the place of this condensed steam, and is in turn condensed as it empties into the horizontal pipe. As this operation continues the water of condensation flows into the drop-leg until a column of water is formed of a sufficient hight to exert a pressure at its base equal to or greater than the drop in steam pressure in the coils and in the riser.

A column of water 1 foot high and 1 inch square at its base weighs 0.434 pound. Therefore, the water in the drop-leg will rise to a hight of $6 \div 0.434 = 13.59 = 13$ feet 7 inches before the pressure at the foot of the column of water is equal to the boiler pressure, or in other words the 84 pounds steam pressure in the loop added to the pressure due to the column of water in the drop-leg (6 pounds) will just balance the boiler pressure. Any additional water entering the drop-leg will overbalance the boiler pressure and flow back through the check valve into the boiler as fast as it appears.

However, if the steam pressure in the loop drops so low that the combined pressure of the steam and of that due to the column of water in the drop-leg is not sufficient to overbalance the boiler pressure, the horizontal and riser are liable to fill up with a solid column of water, and the action of the loop destroyed. The drop-leg should have sufficient hight to prevent this occurring.

From a study of the conditions as described by Mr. Beard it appears that the loop fails to operate due to the following cause: When the steam valves admitting steam to the heating coils are only slightly opened, which is frequently the case in a plant of this kind, most of the steam is condensed in the coils and riser before reaching the horizontal. The riser fills up with a solid column of water in place of a mixture of steam vapor and water, and under these conditions the loop will naturally fail to operate as the column of water in the riser is heavier than the column in the drop-leg.

Let us see how this works out. The hight of the horizontal above the water line in the boiler is given as 16 feet, and the hight of the riser as 24 feet above the heater drains. If the loop becomes water-bound there will be $24 - 16 = 8$ feet more water in the riser than in the drop-leg, and the weight of this water at its base is $8 \times 0.434 = 3.47$, say $3\frac{1}{2}$ pounds per square inch, and this added to the assumed 6 pounds drop in pressure $= 3\frac{1}{2} + 6 = 9\frac{1}{2}$ pounds. This gives $90 - 9\frac{1}{2} = 80\frac{1}{2}$ pounds on one side of the check valve, against 90 pounds boiler pressure. This is an extreme case.

The writer would suggest removing the elbow at the base of the riser and substituting a tee with a drip cock, or a $\frac{1}{2}$-inch valve and a length of $\frac{1}{2}$-inch pipe leading to a trench or other convenient point. With this arrangement the column of water in the riser can be drained off when necessary, allowing a column of mixed steam vapor and water to form, which will rise over and be condensed as mentioned above.

If excessive condensation occurs in the coils, it may be necessary to drain off the water from the riser quite frequently in order to keep the loop in operation. This means good feed water and British thermal units going to waste each time the valve is opened, amounting to quite a little money in fuel in a few years.

The writer would also suggest tapping a $\frac{1}{8}$-inch pet cock into the highest point of the return bend for use in case the loop becomes air-bound. By leaving the cock open just sufficiently to allow the air to escape from the riser, the pressure is relieved sufficiently to allow the steam in the coils to force the water of condensation up and over the bend and into the horizontal.

In one case to my knowledge this has proved all that was necessary to insure the successful operation of the loop. The pet cock was opened a slight amount, allowing the air and vapor to blow continuously, but not sufficient to cause annoyance.

The riser and return bend should be covered with a good nonconductive covering to prevent any unnecessary condensation. The drop-leg should also be covered. The horizontal may be left bare, as it acts as a condenser, and should have sufficient surface to condense the rising slugs of steam as they appear. There is danger, however, of the loop freezing up in cold weather if exposed to the atmos-

phere. It might be a good plan to enlarge the horizontal pipe, say two or three sizes, keeping the riser and drop-leg the same size as at present. The writer knows of several cases where steam loops of this description, where considerable condensation was to be handled, have proved unsatisfactory. A return steam trap set above and discharging into the boiler gives much better results, is positive in operation, and the saving in the long run is greater.

WILLIAM F. FISCHER.

New York City.

Regarding the steam loop described by F. H. Beard, in the August 18 issue, it is not stated whether the valves in the main steam line and in the branches leading to the dry-room coils are open to their full capacity, so as to realize in the coils as high a percentage of the boiler pressure as possible. It is likely that such is not the case, for a pressure in the coils anywhere near approaching 90 pounds per square inch would really be unnecessary, if not unusual for the service required. But even with the valves wide open, it would still appear that the steam would be robbed of its tension by radiation and condensation to such an extent, while traversing the tortuous length of the heating coils, as to produce a very material drop in pressure at the drainage end of the coils. To this drop in pressure, in all likelihood, can be traced the failure of the apparatus to work.

To get the situation intelligently, let us first investigate the principle in the operation of the steam loop.

The horizontal, being situated in a comparatively cool place remote from the boiler and heating coils, is naturally the part of the apparatus in which condensation will occur most rapidly. In fact, the condensation of whatever steam may enter here will be so rapid, as to induce a rush of steam up the riser from the vessel drained by the loop, with a velocity so great as to entrain any water of condensation that may have collected therein; the action being very similar to the entrainment of water by steam flowing to an overloaded engine from a boiler with inadequate steam space. The entrained water having passed into the horizontal pipe, is entrapped therein, together with the water resulting from the rapid condensation of the accompanying steam, by the bend at the upper extremity of the riser. It then flows from the horizontal into the drop-leg, and continues to accumulate above the check valve until it has attained a head sufficient to overcome the difference between the boiler pressure and the pressure in the riser, when the check valve will be found open and the water will pass into the boiler.

Now, the greatest head attainable is limited by the hight of the horizontal above the water level in the boiler, which in this case is 16 feet. We know that the pressure exerted at the base of a column of distilled water under certain standard conditions, is 0.434 pound per square inch for each foot in hight. Therefore, it would take a column of water

$$\frac{1}{0.434} = 2.3 \text{ feet},$$

or, say 2⅓ feet high to overcome a boiler pressure of one pound, and hence the drop-leg in Mr. Beard's apparatus is high enough to accommodate a head sufficient to overcome a difference in pressure between the boiler and drainage end of the dry-room coils of

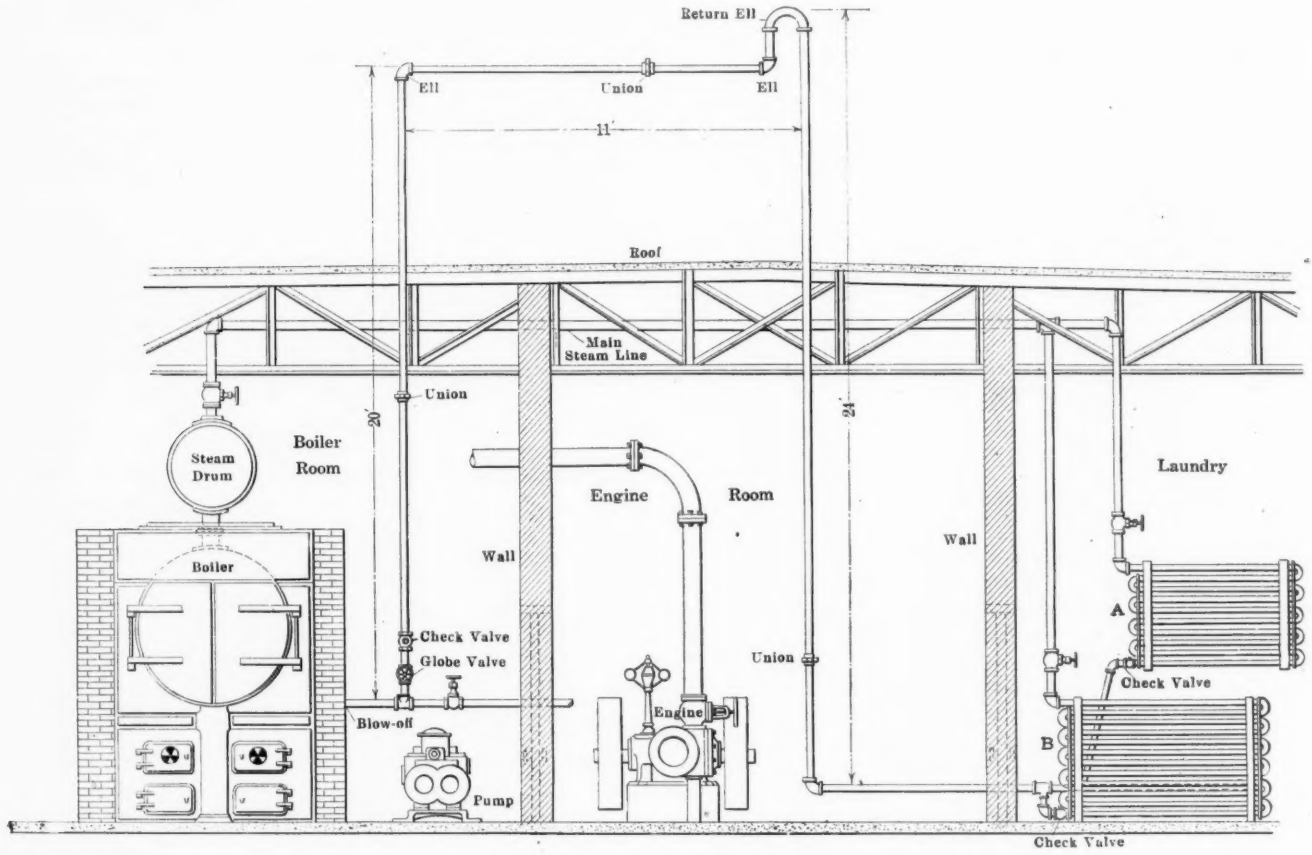
$$\frac{16}{2\frac{1}{3}} = 6\frac{6}{7}$$

pounds per square inch, or, to have a little leeway, say 6½ pounds.

This, in effect, amounts to saying that if steam at a pressure of 90 pounds per square inch as it leaves the boiler can be carried through the dry-room coils without a reduction to less than $90 - 6\frac{1}{2} = 83\frac{1}{2}$ pounds per square inch by the time it reaches the lower end of the riser, the loop will work and the coils will remain clear of water.

It is highly probable that the actual pressure in the coils is considerably below the above figure, and therein lies the failure of the device to perform satisfactorily.

The steam loop is not well adapted to the kind of service required in this case



MR. BEARD'S STEAM-LOOP ARRANGEMENT

anyway, being in general more suitable for such work as draining main steam lines, steam separators, and similar apparatus where water of condensation is merely incidental to the conveyance of steam to a point of utilization, and hence where the difference in pressure between the source of supply and point of delivery is not so great as where such water results from work actually performed, as, in the present instance, the radiation of heat to a dry-room.

H. J. Dixon.

Chicago. Ill.

In the August 18 number, F. H. Beard wishes to know why his steam loop does not work satisfactorily. He does not say what size pipe his loop is made of, but I infer from his letter that it is 1 inch. From my experience with this method of returning condensation I would say that the pipe is altogether too small. A 2-inch pipe would be far more satisfactory.

The principle on which the steam loop works is the difference in pressure between the boiler end of the loop and the horizontal pipe connecting the riser and the drop-leg, caused by the condensation of the steam in that pipe. The drop-leg of the loop must contain a column of water high enough to give it sufficient pressure or head to overcome the pressure in the boiler and friction in the pipe, check valve and fittings. The pressure in the horizontal pipe of the loop is not, as a general thing, much less than boiler pressure, and in his case I do not think it would amount to more than 5 pounds. As the steam-leg of the loop is small, it must be filled with a practically solid column of water, and I think that that is one reason why it does not work, for the reason that one leg will balance the other, or nearly so.

The difference in temperature of the water in the two legs would make a slight difference in favor of the one having the hottest water, hot water being of less specific gravity than cold. By increasing the size of the pipe of the loop, the contents of the riser will be a mixture of steam and water, which has less weight than solid water, and consequently it will rise and flow over into the horizontal leg, and thus find its way back to the boiler.

Air will also cause a loop to work badly and I would suggest that an automatic air valve be placed at the highest point of the riser so that no air can accumulate at that point.

Another thing that he needs is a drip at the bottom of the drop-leg to start a circulation when, at any time, he may have had the heating coils shut off. This is very necessary. I know of no rules or formulas for calculating the size of pipes for a given amount of condensation to be handled, and I doubt if there are any that would prove reliable in all cases. The only way I know of is to follow the design of some other loop under similar conditions as near as possible, or to experiment until a size of pipe is found that will work satisfactorily. One thing is certain, one is not liable to get the pipes so large that the loop will not work.

W. E. Sargent.

Franklin, Mass.

In answer to F. H. Beard's trouble with his steam loop, I think it would be well for him to put in a Holly-loop system, which works on the same principle, but is a little more elaborate. He could, however, drain his returns into a 6-inch header with a check and bleeder on each line before entering the header, for blowing the line clear on starting up in the morning. Then take his condensation from the receiving header and force it up to the top of the boiler house with the aid of a Nason tee. At the top of the boiler house where he now has the return bend, put in a piece of 4-inch pipe about 5 feet long and stand it on end and have the condensation enter the top of the 4-inch pipe and run the line from the bottom of it to the blow-off pipe in the boiler, and connect the same as at present. By running into the top of the 4-inch pipe it will be necessary to have a ½-inch live-steam line with the valve about half open.

The principle of the system is that the Nason tee breaks the condensation into a spray, forcing it into a 4-inch receiver on the top. In falling into this 4-inch pipe, it forms a solid body of water. Thus the weight of the water aided by the boiler pressure of the ½-inch line will force it into the boiler.

A. A. Wagner.

Detroit, Mich.

With reference to Mr. Beard's trouble with his steam loop, I would say that the reason his loop fails to work properly is undoubtedly due to the excessive drop in pressure at the horizontal pipe. As the steam has to pass through radiators which, from the illustration, appear to be made up of lengths of pipe put together with return bends, such a coil interposes considerable resistance to the flow of steam, so that the pressure in the horizontal pipe of the loop is considerably less than that in the boiler, which deficiency must be made up by a column of water in the drop pipe of such hight as will give a pressure sufficient to overcome that in the boiler.

While it is evident that there is six or seven pounds pressure in the drop pipe when it is full of water, yet it is evident that the drop in pressure at the horizontal pipe is such that the seven pounds pressure due to the column of water in the drop pipe, added to the steam pressure existing in the horizontal pipe, is not sufficient to overcome the pressure in the boiler, which condition must exist before the water of condensation will flow into the boiler.

I would advise Mr. Beard to determine just what the drop in pressure at the horizontal pipe really is, and then construct his loop with due regard to the pressure at the horizontal pipe.

Frank Knaps.

New Orleans, La.

Answering F. H. Beard's question pertaining to steam loops, I would say that I have operated one which is very similar to his for several years, and it has always worked well. If at any time it was shut off, all that was necessary to start it was to clear it of air and water.

I think that Mr. Beard's loop does not work for one of two reasons: either its capacity is not sufficient for the amount of water delivered to it, or the drop in pressure in the laundry is too great.

In the first case it would be necessary to put in larger pipe and perhaps make the horizontal pipe longer; in the latter case, it would be necessary to carry the loop higher.

It must be borne in mind that there must be a column of water in the drop pipe sufficient to balance the drop in pressure as well as to force water into the boiler.

If there was a drop of eight pounds or more in the laundry the loop would not work, and if too much water was delivered to the loop it would flood it.

I would also suggest that Mr. Beard drop his discharge pipe below his lowest coil, if possible.

E. T. Reed.

Elmwood, Mass.

Referring to Mr. Beard's steam-loop question, the hydrostatic pressure in connection with the steam pressure in the pipe must be sufficient to overcome the boiler pressure. In the case cited the drop leg is 16 feet above the water line of the boiler, which gives a pressure of approximately 7 pounds per square inch at the blowoff pipe. This would be more than sufficient to force the water into the boiler if the steam pressure in the loop were the same as the boiler pressure. But on studying the sketch shown it is seen that the steam after passing through the main steam pipe has to travel a lengthy and winding passage through a 1-inch pipe coil. There is nothing more favorable for reducing steam pressure than a heater coil, with its many turns and constant heat radiation, and it is most certain that by the time the steam has reached the loop, the steam pressure has fallen more than 7 pounds. With this reduction it would be impossible to force water into the boiler with a drop-leg of only 16 feet.

John French.

Brooklyn, N. Y.

In reference to F. H. Beard's steam loop, described on page 279 of the August 18 issue, I am of the opinion that his loop becomes air bound, which condition can be remedied by placing a ½-inch air

valve in the goose-neck, or highest point of the return ell. This valve can be opened and air released whenever the water fails to enter boiler.

O. B. HULSE.

Chicago, Ill.

A Homemade Calorimeter

The accompanying drawings illustrate the construction of a steam calorimeter

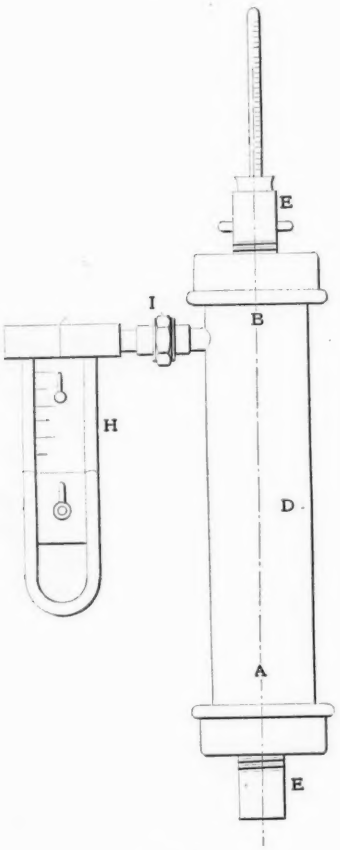


FIG. 1

of the throttling type, which is made of pipe fittings. Fig. 1 shows the front elevation, Fig. 2 the side elevation in section on line *A B*, Fig. 1. Figs. 3 and 4 show front and side views of the mercury gage, shown attached in Fig. 1. Referring to Figs. 1 and 2, the body of instrument *D* is made of a piece of 1¼-inch pipe, 7 inches long and capped at both ends as shown. Each cap is drilled and tapped for a ½-inch nipple about 1 inch long. At the upper end of the 1¼-inch pipe a hole is tapped at *J* for a ⅛-inch nipple and at right angles to *J* a hole is tapped for a ¼-inch nipple and globe valve, as shown in Fig. 2.

At *F* in the nipple *E* is a cork through which the thermometer *G* passes, which should register about 300 or 350 degrees Fahrenheit. On the ⅛-inch nipple put a ⅛-inch union as at *I* for the mercury gage.

Referring to Figs. 3 and 4, the piece *K* is of brass, 1¾ inches long and ½ inch square. Drill and tap one end for a ⅛-inch pipe and drill a small hole in to meet this hole from one leg of the glass tube *T*. This tube should be about ⅜ inch external diameter, and after being bent should be about 4 inches long and about 1 inch between each leg. The tube can be bent by heating in a gas or gasolene flame. After bending the tube, drill two holes in the under side of the brass piece *K*, about ⅛ inch larger than the tube. These holes are shown in Fig. 4. The small hole on the left should be countersunk on top, as shown. To fasten the tube in the piece *K*, insert the tube in the holes and force a rubber gasket *R* around the tube to the bottom of the hole and fill the hole around the tube with plaster of paris as shown at *P'*.

Between the tubes is fitted a piece of hardwood *L*, the piece being fastened by the cross piece *N*. On the hardwood piece *L* is mounted a scale *M*, made of a thin piece of sheet brass and slotted at

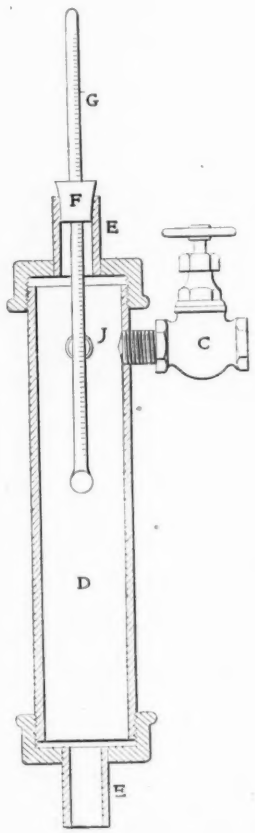


FIG. 2

P P"; the slots should be about ½ inch long, the scale being mounted on the wood piece by a screw at *P*, and by a thumb nut at *P"*. This will allow the scale to be adjusted to correspond to the hight of the mercury. The scale is graduated into ½-inch divisions, each division being graduated in ten parts, as shown.

To use the calorimeter, connect valve *C* to a nipple in a steam pipe close to the boiler. This nipple should extend into the main steam pipe about to the center. Attach the mercury gage to the union *I*, and fill the glass tube with mercury up to the zero mark on scale. Cover the body of the instrument with hair felt or mineral wool and insert the thermometer in the nipple *E*, as shown in Fig. 2.

Open the valve *C* until the mercury gage shows a slight pressure above atmosphere; this pressure will depend somewhat on the atmospheric pressure at which the instrument is being used. If the pressure of the atmosphere as shown

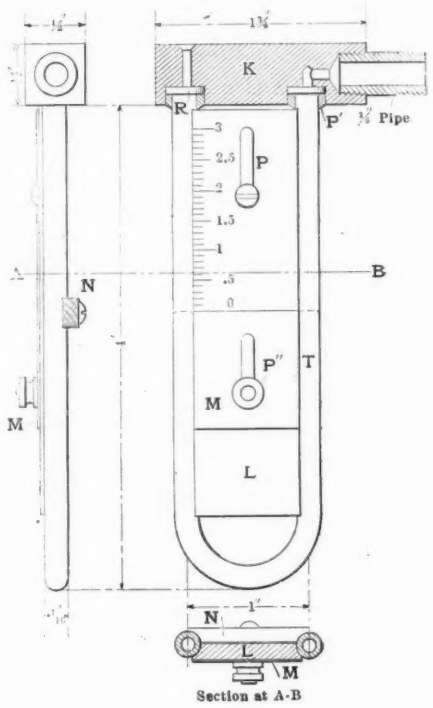


FIG. 3 FIG. 4

by a barometer, where the instrument is being used, is 14.7 pounds, open the valve *C* until the mercury gage shows a pressure of about 0.6 of an inch which will equal 0.294 pound as $0.6 \times 0.49 = 0.294$. This added to 14.7 equals 14.994 or 15 pounds absolute. After the instrument is warmed up take a reading of thermometer *G*, also of the pressure as shown by the steam gage on the boiler.

The formula for the per cent. of moisture in steam is

$$X = \frac{(H - h) - (T - t\,0.48)}{L} \times 100,$$

where

X = Per cent. moisture in steam,
H = Total heat of steam at absolute pressure,
h = Total heat of steam due to absolute pressure in calorimeter,
T = Temperature of steam as shown by thermometer,
t = Temperature of steam due to absolute pressure in calorimeter as shown by mercury gage,
L = Latent heat of steam at absolute pressure,
0.48 = Specific heat of superheated steam.

As an example, take the boiler pressure

at 120 pounds (absolute); the total heat in steam at this pressure as shown by steam tables equals 1186, and the latent heat is 874.

If the absolute pressure in the calorimeter as shown by the mercury gage is 15 pounds, the total heat at this pressure is 1146.9, and the temperature due to this pressure is 213 degrees. If the temperature shown by the thermometer is 258 degrees the formula becomes

$$\frac{(1186 - 1146.9) - (258 - 213 \times 0.48 \times 100)}{874} =$$

2 per cent. of moisture in the steam.

R. L. MOSSMAN.

Fremont, O.

How Should Gas Be Metered and Charged For?

On page 113, July 21 number, I notice a few errors in my letter, as follows: "From an 8-inch main, with a 13-inch lead to the meter," should read: "with a 3-inch lead to the meter."

Again, "if the pressure exceeded 22 pounds, the meter will register more gas than it will at 8 pounds." This should read, "exceeds 22 ounces, the meter will register more gas than it will at atmospheric pressure."

G. W. FELVER.

Muncie, Ind.

The Lake Lifts Itself

In regard to J. E. Bates' letter on page 154, July 28 issue, I think he is as far from perpetual motion as everyone else. The very fact that the water seeps away in the well proves that it goes to a lower level than the bottom of the lake and does not return to it. See illustration. If there was any connection between the lake and the well the latter would soon fill up and the whole arrangement would come to nought.

As it is, Mr. Bates simply drains the lake of about 8547 gallons of water for every 1000 gallons raised to the top of the hill according to the formula

$$\frac{G \times 65 \times h}{100 \times H} =$$

water raised per minute, in which G = gallons per minute running from lake to ram; h = hight from intake to ram, in this case 18 feet, and H is the hight to which the water is raised, in this case 100 feet.

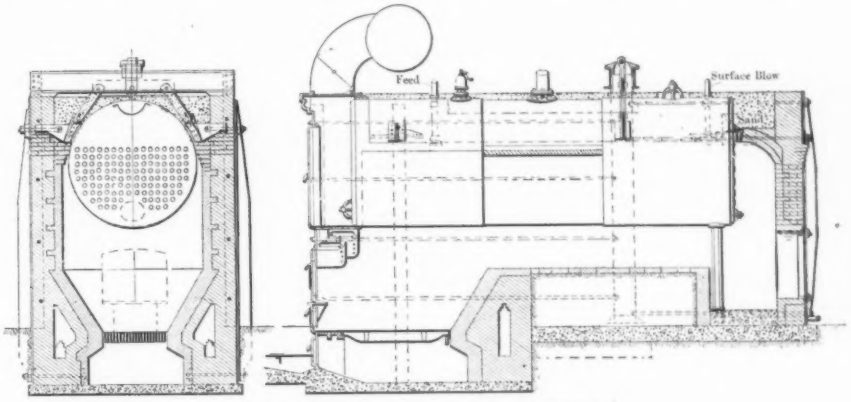
R. CEDERBLOM.

Gary, Ind.

Wood Burning Furnace

The first requisite for a furnace for burning wood is that the space between the shell of the boiler and the grate should be at least twice the depth required for coal and three times the depth would be better. This may be putting it in a rather indefinite manner, because the depth of the furnace for coal varies considerably with different constructors, so to make it more definite I will say that the depth of furnace for a 150-horsepower boiler, having a shell 6 feet in diameter, should be about 4 feet 6 inches.

The next requisite is that the width of the grate should be only about half the diameter of the boiler with the side walls sloping up a matter of about 2 feet 8 inches. The next requirement is that the fire door should be made double-deck, the lower portion of which should be much heavier than the upper portion to stand the rough usage it frequently receives when cord-wood is fired, and preferably made in one door with heavy fastenings. The object of these heavy fastenings is to prevent the door swinging open when a log has been shoved partly in, but which, for some reason must be withdrawn, with the likelihood that a knot may catch in the flange of this door and jerk it open. Providing a heavy horizontal flange or shelf on the upper edge of this door will make a much better design for this class of work. It goes without saying that this lower door is not to be opened in the ordinary running of the furnace, because there should always be a deep bed of incandescent combustible up to at least the top of the lower door; therefore, the upper door becomes the legitimate firing door and the lower door used simply for tooling the fires or cleaning off the grates.



MR. WOOLSON'S WOOD-BURNING FURNACE

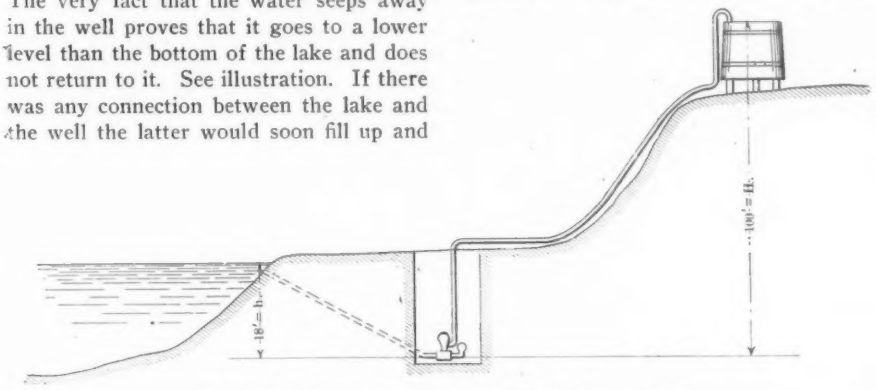


DIAGRAM ILLUSTRATING MR. CEDERBLOM'S ARGUMENT

So far as the character of grate bars themselves are concerned for fuel of this kind, I do not think it makes any material difference so long as liberal air space is provided. I would suggest, however, that the bridgewall be made unusually heavy to avoid being knocked to pieces by careless firing of 4-foot wood, which, under some conditions, will knock the brick loose. The wall itself, however, should be racked back quite a little from the grate up.

I believe that I was the first man to suggest a narrower grate and deeper furnace for wood, although it is the common practice with many to increase the grate instead of decreasing it. Whether or not exception has been taken to this during the past seventeen years, I do not recall, but my views on the subject are just as strong today as they were in 1891. This style of furnace was first used in Cuba, where wood was largely used for fuel in some sections of the island, and it was but recently I was handed some plans to criticize and I found that my suggestions of 1891 had never been absorbed by the parties who have asked me to criticize their plans, for in them they had provided the same wide grate and shallow furnace that I unhesitatingly relegated to the past, showing conclusively that my efforts of 1891 had not been of the slightest value so far as these particular parties were concerned.

I have in this letter confined myself to simply the furnace criticism, and have not gone into the matter of general setting or hanging of the boilers, nor to the neces-

sary air ducts, etc., as it might take up too much space, but all of these features should receive proper attention.

Orosco C. Woolson.

New York City.

Boiler Explosions and Scale

I read with interest the article by William H. Boehm, on page 333 of the August 25 issue of Power and The Engineer. As superintendent of boilers and flywheels for the Fidelity and Casualty Company, which position I understand that the author of said article holds, he probably has had better opportunity to study running conditions of more boilers than any operating engineer, still my opinion is that a good many operating engineers, as well as the writer, do not agree with him as to "the most frequent cause of boiler explosions."

Any operating engineer worthy of the name at all does what he can to keep his boilers free from scale, but I am inclined to think the average man does it more on general principles, looking at scale as a reducer of efficiency rather than a possible cause of explosions. If fully explained to a layman what a tremendous force is stored in a steam boiler under pressure and how quickly the thin sheet of sheel would be heated to a softness incapable of confining this force to its proper space if the water for some reason was kept away from it, he would probably not feel quite comfortable after having a good look into a roaring furnace with everything at white heat; still, the engineer is not accumulating any gray hairs just on this account; when the steam drops he is most concerned how to increase the heat as much as possible.

Experience has shown that the fire sheet, the most dangerous part in this regard, is generally the last place to accumulate any solid deposits of scale. When a boiler is allowed to scale up badly, most of the deposits are found between the tubes on the head and tube ends, but all these parts are comparatively cool and the scale has to be pretty thick indeed before the average inspector declares the boiler in a dangerous condition on this account. As a rule when a boiler is weakened by heavy deposits of scale there is ample warning of threatening danger; tubes commence to leak at the ends, and bags and generally gradually form blisters.

What are more dangerous, in the writer's opinion, are oil and grease deposits, as it takes so very little of either to cause a bag or blister. Apply a blow-pipe flame to steel or iron covered by water; as long as the wet side is clean the flame has no effect on it; but only wipe the surface with a greasy rag and there is no trouble at all to burn a hole through the metal.

If scale is the most frequent cause of boiler explosions, why the crusade against lap-riveted boilers? Is it not a fact that where the cause of explosion has been determined with any degree of accuracy it has only too often been a hidden crack in the sheet where no amount of scale could be blamed for its presence, also when corrosion, pitting and grooving has reduced the plate to a state where it can no longer withstand the pressure, the condition cannot be attributed to scale, in fact, many engineers prefer to have some scale in their boilers to protect the metal from chemical actions.

Danger from scale can easily be guarded against, but for hidden cracks there is no remedy and the writer is of the opinion that if we had some kind of an X-ray apparatus, for instance, to show the actual condition of boilers now in daily use, more of them would be condemned on account of hidden defects in plates and riveted joints than from any damage caused by formation of scale.

R. Cederblom.

Gary, Ind.

Condenser or Heater

On page 153 of the July 28 issue, Markham & Co. inquire about the expediency of putting a heater in the exhaust pipe of a condensing engine.

If they can take water from the hot well it will not pay, as they would only gain 15 degrees, and probably not more than 10 degrees. The water from the hot well produces scale and they want to use city water.

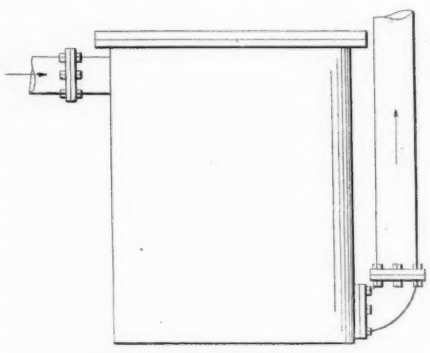


FIG. 1. NO DRIP REQUIRED

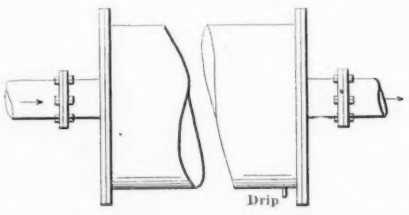


FIG. 2. FAULTY HORIZONTAL ARRANGEMENT

If they get a 27-inch vacuum their exhaust will be about 110 degrees and their feed water heated to 100 degrees or to 105 degrees. If a 26-inch vacuum is carried their feed water may be heated to 120 degrees. Every 10 degrees will make about 1 per cent. saving in coal.

The heater if properly piped will not affect the vacuum, and there will be slightly less water required for the condenser. If care is taken that the exhaust pipe be thoroughly drained there will be no trouble, if no tube in the heater breaks, or any other opening occurs to let a large quantity of feed water into the exhaust. Of course, everything must be tight to prevent air leaks.

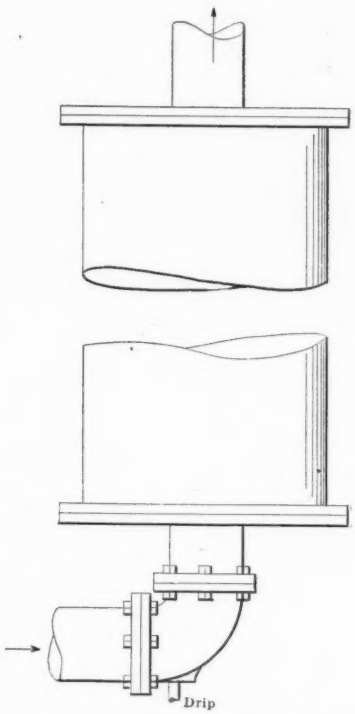


FIG. 3. FAULTY VERTICAL ARRANGEMENT

I once had a heater in the exhaust pipe of a 28 by 60-inch engine as shown in Fig. 1. The steam entered at the top and passed out at the bottom. It will be noted that steam cannot get out without taking water with it, and this exhaust was always clear and the vacuum steady.

Should the heater be put in a horizontal position, as shown in Fig. 2, it would be necessary to put in a drip at the lowest point farthest from the engine and connected with a trap that would drain water from a vacuum. Should there be an accumulation of water up to the level of the exhaust, that much of the heater would be inoperative, and there might be danger of throwing the whole body of water up into the exhaust.

Should the heater be set vertically as in Fig. 3, it would be necessary to drain it into a vacuum trap. The trouble with water here would be due to its accumulating in the horizontal pipe and would reduce the vacuum by 2 to 4 inches, when the excess pressure on the engine side of the exhaust would cause a wave motion and throw the whole amount of water over in a body, the vacuum then returning to its best. Probably no harm would be done, but the vacuum would be irregular.

W. E. Crane.

Waterbury, Conn.

Some Steamship Repairs

The steamship "Ohio" was used as a sort of experimental laboratory for the trying out of many new ideas, the success or failure of which meant their use or rejection in the new ships of the same line.

The "Ohio" was fitted out by Howden with his well-known method of forced draft. The method of producing the source of power for driving this fan was by a single-cylinder engine, direct-connected to the fan shaft. The direct-connected engine proved to be the correct idea in the end but, as at first installed, the parts were of too light construction and it flew to pieces when put into use.

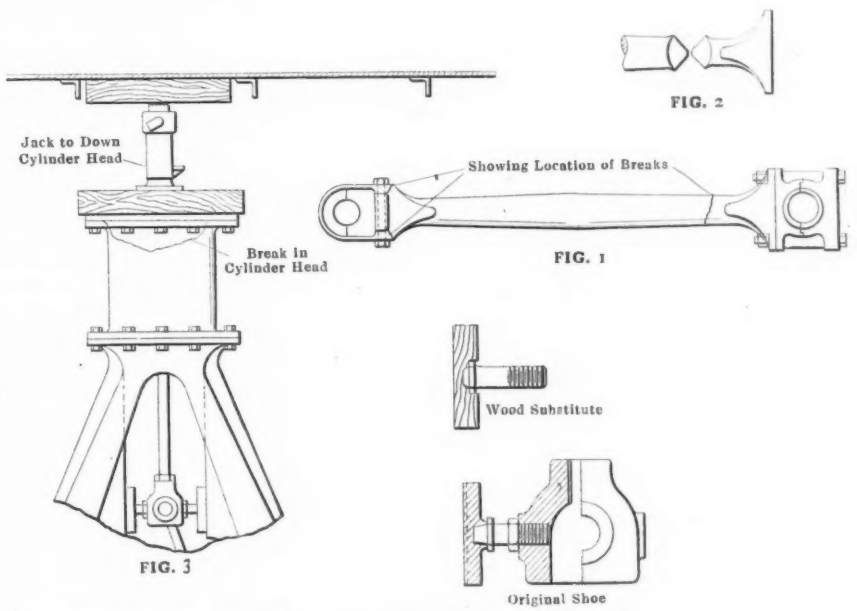
The next step was to take from the coal-bunker space sufficient room to put in an upright vertical engine and connect it by a belt to a pulley on the fan shaft. With this arrangement we had sufficient power, and along with the power all of the kinds of trouble that one can well imagine.

This fan and engine were arranged with their shafts athwart ship and were spaced about 12 feet from center to center, thus bringing the belt lengthwise. This arrangement was satisfactory for calm weather, but when any considerable rolling took place, the body of the belt would drag it from the pulleys, the engine would race, the draft was gone and the ship's speed would be falling off very fast.

Persistent efforts were made to make a success of this method of drive; flanged pulley on fan, vertical guide rollers on supports placed between the fan and engine, flanged pulleys arranged for supporting and tightening the belt; all to no purpose.

Then, all the then known kinds of belt —link, canvas, rawhide and tanned—were tried with results the same as before. Being at that time a "greaser," I was taken from the regular engine-room watch and, with the storekeeper, constituted the emergency force whose duty was to keep the fan in effective motion.

On one occasion, when the rawhide got particularly "snakey," it was astonishing how the belt would ride up on the flanged pulleys and twist itself inside out. The emergency force took turn and turn about, holding two broom handles on either side to keep that belt doing business. Finally No. 2 engine started in to follow the lines of engine No. 1, and it made a close second, too. The first thing to let go was one of the crank-pin bolts on the stub end; the other bolt then bent enough to allow the brass to slip from the pin, then the pin struck under the end of the rod and broke the piston and cylinder head; another revolution and the crank caught the brass right and drove it through the hollow leg of the A-frame, also breaking the crosshead shoes and the rod itself in two places. We juniors had no sooner got the wreck cleaned up before we were detailed off to commence repairs on our allotted parts.



DETAILS OF REPAIRS ON A STEAMSHIP

The connecting rod was of the marine type on the crank-pin end, but had a solid forged strap on the upper or crosshead end. See Fig. 1. We had a small portable forge which, with the anvil, was taken to the fireroom and lashed to stanchions; the sea, as usual in breakdowns, was rough.

We learned, among other things, that it is not as easy to weld low-carbon steel, of which this connecting rod was made, as it is to weld wrought iron. At first we tried to make the usual scarf weld, but after making two or more ineffectual attempts, due to burning the steel, the burned portions were cut off and the ends were upset to a slightly conical shape, as shown in Fig. 2. Then by careful attention to the heating, which, for steel, must not be allowed to attain the sparking point, a first-class butt weld was made on the crank-pin end of the rod.

The solid strap on the other end was so badly broken and out of shape that it was given up as hopeless. For a substitute, we took the "old man" apart and that part which is shifted up and down, or against which the ratchet center is held, was found to have a hole about the size of the crosshead pin.

This time we could not make a butt weld, because the eye would crush out of shape if hammered upon while hot. With our previous experience on the other end to guide us, we were careful not to burn the steel rod, at the same time the iron eye was given a good white sparking heat; as this proved to be a good weld, too, our connecting rod was considered complete.

In the meantime, others had found that our deck winches—hoisting engines —had the same diameter cylinders, but the pistons were thicker and therefore could not be used as a whole. The rings and follower were discarded and the body of the winch piston was riveted to the fan-engine piston rod, this rod having escaped with being slightly sprung.

No attempt was made to make or use any piston rings, as all steam which passed the auxiliaries went to heat the feed water, or was exhausted into the low-pressure receiver.

When the cylinder head went off it was not broken, but took several studs and a piece of the cylinder itself along with it. At that time there was on the market a brand of sheet packing which had, for us, a convenient characteristic. It would, when hot and pressed between pipe or other flanges, squeeze out to almost nothing. We took the piece of cylinder away from the head and cutting a strip of the packing, placed it between the cylinder and the part broken out. A new gasket was also made for the head, from the same material. The original holes for the studs in the flange of the cylinder head were drilled so close to the barrel of the cylinder that we could not substitute through bolts for the studs which had been torn out, so an hydraulic jack was placed on top of the cylinder head and its pressure was resisted by the deck and several tons of coal overhead (see Fig. 3). For the two broken crosshead shoes were substituted some pieces of oak, which the carpenter had gotten out under instructions.

With these extensive repairs, the engine never ran more quietly and it gave off nearly the full rated power. This was its last run, however, for when next in port we had a new direct-connected fan and engine installed.

D. A. Manson.

Washington, D. C.

Trouble on a Trolley Circuit

In the July 28 issue, G. S. Glick, in his answer to Mr. Hamilton's "Trouble on Trolley Circuit," makes some statements which are evidently wrong and might be misleading to some.

In the beginning of his explanation he says: "The voltage is about the same at both the + and — wires."

With due respect for Mr. Glick, I wish to state that we do not have voltage *at* nor *on* a wire, but we have a certain voltage, or difference in electrical pressure *between* two wires or points.

If the station voltage is 500 volts, then according to the theory of electrical pressure, the positive wire is at a pressure of 500 volts above the negative. Therefore his statement that the positive and negative wires are at about the same voltage is without scientific foundation.

If the pressure was the same at both wires they would be neutral with respect to each other and a short-circuit between them would result in no flow of current.

Mr. Glick also has a different understanding of the circuit breaker from that which I have. In a good circuit breaker the tripping depends on the pull of the tripping magnet, and the strength of a magnet is dependent on the ampere-turns, which are the product of the number of amperes and the number of turns in the tripping coil.

In a given circuit breaker the number of turns in the coil is a fixed quantity, therefore the tripping of the breaker is really dependent on the strength of the current in amperes. The voltage has nothing to do with it except to drive the current through the coil. One ampere at 10 volts will have the same tripping effect as one ampere at 100 volts.

The voltage must be considered, however, in installing a circuit breaker, as the break must be of sufficient length to break the arc; the higher the voltage the longer will be the arc, hence the break must be longer for high-voltage circuits.

Circuit breakers are built only to limit the current and not the power, and should open at the limit regardless of line losses.

In some instances it may be possible for the ammeter to register a higher current than the breaker limit and the breaker remain closed. It must be remembered that the moving parts of an ammeter are very light in weight and possess but little inertia, while the trigger and armature of a circuit breaker have considerable weight and inertia; therefore, it is possible for the current suddenly to go above the breaker limit for a moment without opening it.

Also the ammeter may register a greater current than actually flows, unless it is absolutely dead beat, and in this way leave a wrong impression as to the actual current carried by the circuit breaker.

I think Mr. Glick is also mistaken in his statement that the line loss is not registered by the station watt-hour meter. A meter correctly connected on the station switchboard will register the total output of the station even though it be one-half or all lost in the line. The current coil of the instrument carries the total current, and the potential coil is subject to the full generator voltage, consequently the true output of the station will be registered. It does not matter in which side of the circuit the instrument is placed so long as the current flows through it in the proper direction. If the meter were out on the line where the line loss would be between the instrument and the station, then the line loss would not be registered. In this case the potential coil would not be subjected to the full voltage, but only to that at the instrument, consequently the speed of the instrument would be slower and the registered output less.

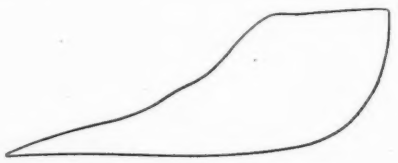
I repeat here what I stated in my former letter on this subject, that with a constant busbar voltage and an increased load in amperes there *must* be a corresponding increase in the output if the station gives out direct current.

C. L. GREER.

Handley, Texas.

A Case of Bad Valve Setting

Referring to the indicator diagrams submitted by Mr. Stauffer, on page 234 of POWER AND THE ENGINEER of the August



FORM OF DIAGRAM SUGGESTED

11 issue, I would say that all events are late. I would advise turning the eccentric ahead until the admission line comes up well, and compression and lead are correct for an engine of the type indicated. This he can ascertain from a study of any indicator instruction book. He does not give the speed of the engine, and hence it is impossible for one to advise how much lead and compression should be given in this case, or give the form of diagram he should try to approximate in making his corrections.

I should advise trying with an approximation of the form shown herewith, and Mr. Stauffer will find that by moving his eccentric ahead a little at a time, and noting the effect, his diagrams will gradually assume a form more like the diagram shown. If his engine is a high-speed engine, he will likely have to give more compression than is shown, but the form will give him a good idea of what he requires.

It is not indicated which is the head or crank-end diagram, but I will say that the right-hand diagram on the card shows events later than the left-hand, and it may be necessary to equalize the lead and compression by moving the valve. This will be a very simple matter, and I feel sure that Mr. Stauffer will notice a difference in the steam consumption of his engine.

WILLIAM WESTERFIELD.

Lincoln, Neb.

Explosion in Air Compressor System

In POWER AND THE ENGINEER of August 25 is an account of an explosion of an air-compressor system, with speculation as to the causes. It speaks of reservoirs that had drains 3 inches from the bottom, and intimates that it must have been filled up to the drains with oil and dust.

In compressing and using air there are two things that give trouble: water, and carbon from the oil. It is important that a pure mineral oil shall be used with a high flash test. A great many cylinder oils are compounded, and compounded oils produce a carbon that sticks the valves, collects on valve faces and other parts of the cylinder and valve chambers. This carbon dislodged and mixed with a little oil is liable to take fire in the presence of hot air and cause an explosion in the compressor cylinder or valve chambers, and it is at this point that most explosions occur. An interesting question would be as to the kind and quantity of oil used. Air under pressure will give up its moisture when cold and this causes trouble from freezing in cold weather in the machines using it, and it will even freeze up pipes that have low pockets.

The reservoirs mentioned must have been filled with water, and as oil rises to the top of the water, the oil would have been drawn off, leaving the water.

There should be a reservoir near the compressor and the nearer it comes to being a cooler the better. This reservoir should have a drain at the bottom so that all water, sediment, etc., can be drawn out. It should be made so as to run half full of water with a drain at that point, connected to a trap. The air should enter at the bottom, pass through the water and be taken out at the top. The piping should be so arranged that the water will not flow back into the cylinder. The object of passing the air through water is to dry it, as it has been found that it is the best separator yet devised. It also separates the oil and the dust that come in with the air. As the oil rises to the top of the water it is continually being drawn off with the excess water through the trap.

For those that can afford it, it is a

good idea to have a reservoir of water through which the air entering the compressor passes, the top of the water having sufficient area so the air will not have a lifting effect. This will separate and keep dust out of the cylinders, and it also helps dry the air, but is not as efficient in this respect as when the air is under pressure.

W. E. CRANE.

Waterbury, Conn.

Trouble in the Boiler Room

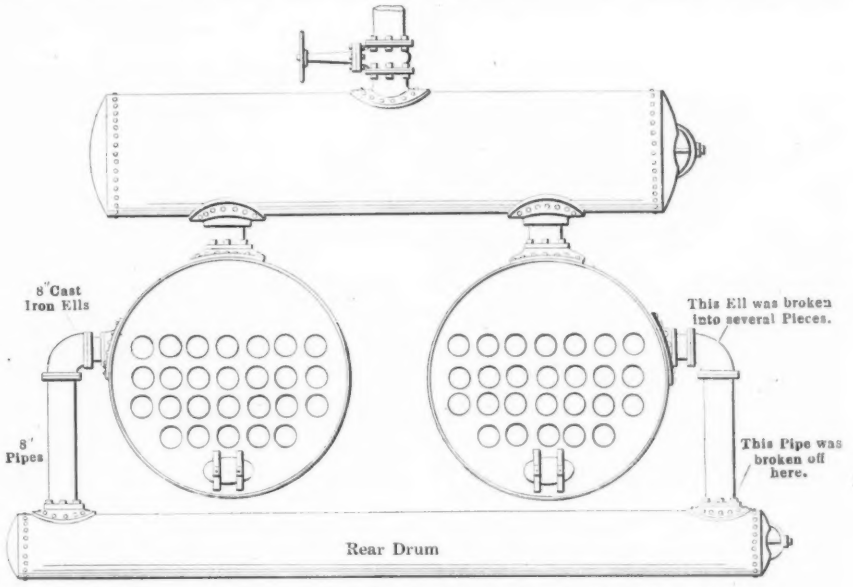
From time to time there had been placed in the boiler room of a street-railway power station shell boilers of about 125 horsepower each, until there were twenty-eight in all, set in batteries of two each, with a single down-draft furnace under each battery. The additions had been made in every case to take care of the increasing load. The boilers were connected to the header, which was of 20-inch pipe and something over 200 feet long, by 10-inch leads from a cross-drum over each battery. The header had a 20-inch valve about midway of its length to permit of repairs being made on either end without shutting down the entire plant.

The ground on which the boiler room was built was a swamp which had been drained some years previously, but even then the surface water in the soil stood within 5 feet of the floor in wet seasons.

Provision had to be made for another increase in capacity, and to accomplish this increase, it was decided to replace all the shell boilers as rapidly as possible with water-tube boilers of much greater capacity per unit, as some of the shell boilers had been in use nearly 20 years with water which deposited scale and mud in enormous quantities. In fact, the insurance companies had refused to continue the insurance on some of them several years before.

The first indication of serious trouble being imminent was the melting out one night of the fusible plugs in the rear end of the top row of flues in battery No. 12, a 72-inch by 18-foot battery having about thirty 6-inch flues in each boiler. The night water tender, who had been considered exceptionally diligent, was severely lectured, though he violently maintained that the water had not been below the first gage at the time the plugs melted out. The water column was examined and found fairly clear, the boilers were cleaned and the plugs replaced, and the battery went on the line again, leaving a cloud upon the water tender's reputation for veracity.

The boilers had not been in service twenty-four hours when the plugs again melted out, this time on the day water tender's watch. This time a more thorough examination was made, and it was discovered that the front end of the battery had settled about 4 inches, and that the rear ends of the flues were uncovered when there was one gage of water in the glass, whereupon the night water tender's reputation jumped up to par again.



ARRANGEMENT OF SHELLS AND DRUMS; FRONT DRUM NOT SHOWN

No. 2 battery had just been replaced by a water-tube boiler, but the pipes for the steam connections had not arrived yet. The next battery of shell boilers had been torn down preparatory to changing it to water-tube, so the plant was limited to twenty-four boilers, with the winter load, the bane of street-railway life, just coming on. The battery which had settled could not be spared long enough to do the work necessary to level it up again, and the management declined to go to any avoidable expense on the flimsy old shells anyway, as a couple of months' service was all that was wanted of them. So it was decided to do the Jim Bludso act, and run them through or "bust."

The water was carried a few inches higher in the glass of No. 12 battery, and daily levels were taken on it and the adjacent boilers with a transit, but no further setting could be detected. Everything went on lovely for a few weeks, and No. 2, the new water-tube unit, was connected up just in time to take care of the increased load from a new schedule which placed a number of additional cars in service.

About 11 p.m. one cold night near the end of November, there was a report in the boiler room like the discharge of a cannon, followed by a continuous roar. The firemen were all driven out of the boiler room, which was full of steam, and occasionally a brick would crash through the windows in the neighborhood of No. 12 battery. The water tender could not tell just what was wrong, but said that there was a very hot fire under nearly all the boilers in service, and by crawling on his hands and knees with his nose almost touching the floor, he was able to get nearly all the middle doors open to check the fires.

In about five minutes the engine room was in total darkness, and as the roar of escaping steam in the boiler room had now weakened considerably, a couple of the men volunteered to close the 20-inch valve in the header, which would prevent the steam from the first six batteries from getting to No. 12, the stop valve of which was closed, which ended the trouble.

The firemen got busy on the fires in the lower end of the boiler room, and presently one of the engines was started.

The cause of this accident was that the boilers in settling, during a period of unusually wet weather a short time before, had brought the rear drum of the down-draft furnace down upon the brickwork beneath it, though it was left apparently free as seen from the ends. The circumstance was not discovered in the examination made when the settling was first noticed. Thus the drum was forced to sustain nearly the whole weight of the boiler through an 8-inch pipe connection between it and the boiler. This connection was made in this case by pipes and ells running from the top of the rear drum near each end to a point about midway in the side of the boiler shells, as shown in the illustration. The breaking of the ell made practically two 8-inch openings to the atmosphere, one from the shell and one from the drum, as illustrated. Being cut in on a large header with twenty other boilers gave these openings an enormous supply of steam, and it is a wonder so little actual damage was done.

Everybody connected with the place breathed much more freely when the fires had been drawn for the last time on the last of the old shells, which then went to a well earned repose on Cohen's scrap pile.

H. R. MASON.

St. Louis, Mo.

Some Belting History

By J. Crow Taylor

Belting as a means of transmitting power had its conception and development along with the advance to high piston speeds. The earlier engines were all of slow speed and transmitted power by the use of cumbersome gears and various other crude appliances. According to Oliver Evans, who published a "Millwrights' Guide," back in 1850, wooden shafts, wooden drums and wooden gearings were made use of quite extensively for power transmission, and especially in America. England was using belts, or straps as they were termed, for power transmission as far back as the turn of the century, or more than 50 years before that. This means of transmission, however, was a little slow in finding its way into America, because development was still in the pioneer stages. When the use of belting was started on this side, however, rapid progress was made, and it was only a few years until Englishmen visiting in this country were astonished at the strides made in this direction. In fact America soon became the great belt center of the world, and is yet for that matter.

Probably the best brief record of the history of the belt and its development was given by Charles A. Schieren, back in 1880, in an article contributed to the old *Age of Steel*, entitled "Belting, its Origin and Progress." "In the early part of this century," he says, "the first attempts were made by English machinists to transmit power by bands or straps made of leather. This transmission of power from one line shaft to another needed a peculiar quality of material, one that combined pliability, solidity and strength, and leather was the only known substitute which suited that purpose. Previous to 1820, and even up to 1835, most of our machinery, which consisted of looms, etc., was imported from England and had all the necessary belting sent with it. These early belts were joined by being lapped 6 or 8 inches and sewed along the edges without any attempt at chamfering to make the joints even. In some instances this was supplemented by the use of large, heavy rivets which were put along in the center, making a very clumsy joint. Even with the slow speed of these early days the belts, with their crude joining and on account of the strain they were made to stand, were far from satisfactory. So much so, in fact, that machinists became rather discouraged and drifted back toward gearing again."

Gearing and upright shafting were largely used up to 1860. Belt making was hardly known up to 1840, though it is true that leather dealers kept some special leather on hand regularly to supply the small call that was made for it. In 1842, William Kimble commenced the manufacture of leather belting at 33 Ferry street, New York. The foreman of his tannery, "Fred" Wood, invented a machine which was necessary to stitch the point of the belt in order to make it run smoothly. From this start, Yankee push and energy soon led to the manufacture of leather belting that was superior to that of England, and since that time we have led the world in its manufacture.

During the war the demand for belting increased enormously because of the activity in machine shops and factories catering to the demand of the Government for munitions of war, and thus led to the use of all parts of the hide possible and to the incidental deterioration in quality. At this time Mr. Underwood invented a method of making belting out of pieces of leather 6 and 7 feet long by chamfering and fastening them together with copper rivets, and the copper rivets brought into use by him may be found in many places today where belts are used.

In the midst of the great demand for cheap belting, Joseph B. Hoyt revolutionized the trade by going to the other extreme. He gave orders that all his belts should be made with short laps only, and that in putting together the butt lap should be joined to the shoulder lap. He ordered also that only 36 inches in the center of the hide should be used and every width of belt should be stretched by itself. Out of this idea, Mr. Hoyt made both a reputation and a fortune.

There now came a time when a demand was felt in the power-transmission line which had not been undertaken before. There was a call for belting which would transmit from 500 to 1000 horsepower. One of the greatest troubles experienced in undertaking to make belts of such large requirements came from the fact that the general width of leather to be obtained from a single hide was seldom in excess of 36 inches, with small portions running to 45 inches. Orders were coming into the factories for belts up to 75 inches wide, and to solve this problem satisfactorily was a difficulty which has been a subject of experiment from that day to this. But the belts have been made by doubling and jointing the leather.

In 1864, Mr. Clark, of Boston, Mass., originated a system of splitting leather to a given thickness and making it into a double leather belt of uniform thickness throughout. A number of experiments have been made between that time and this in the effort to combine textile material and leather, both with leather as a bulk and a cloth filler, and with cloth as a body with a combination of felt and leather scraps. In 1872, Clark & Slemmer, of Philadelphia, patented a belt of this kind. In 1879, J. Thompson, of Cincinnati, Ohio, patented yet another method of making leather belting. In this patent belt of Mr. Thompson's, the material was cut into strips which stood on edge in running over the pulley, with rivets every inch going through the belt from edge to edge.

When electricity began to be a factor in the industrial world and before it began to play any part in power transmission proper, there was a demand for a still better belt than any which had been produced. What was wanted was a belt well balanced, one that would stay that way through continuous service, would run smoothly without undue vibration and with sufficient adhesive quality to transmit power to the small high-speed pulleys which were the essential feature in dynamos. In response to this demand, Mr. Schieren did some experimenting in the way of stitching leather and using wire screws to hold the plies together at the edges, the result being the invention of the belt known as the "Electric." About 1878, the C. A. Schieren Company introduced link-leather belting, securing a patent on the process in 1888.

Looked at in one way, it would seem a peculiar irony of fate that electricity and dynamos, the very things that really stimulated the high quality in belting and called for the use of enormous quantities, should eventually supersede belting extensively in its own work of transmitting power. It goes without saying that

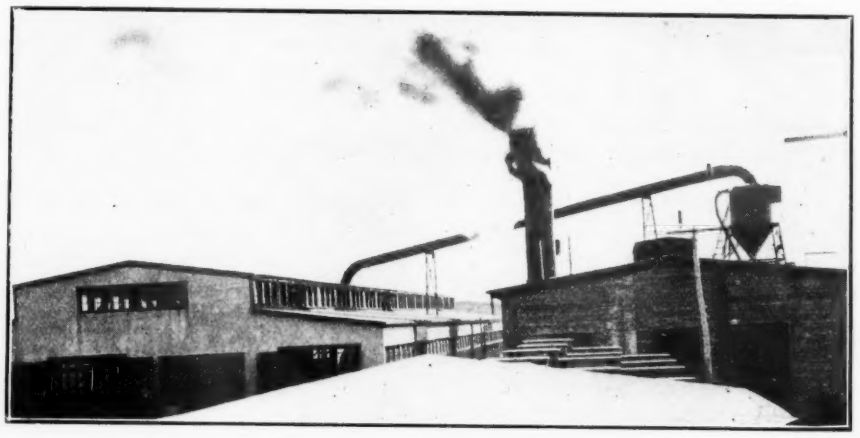


FIG. 1. FROM WOODSHOP TO BOILER ROOM IN THE WABASH PLANT

there is lots of belting still used, and probably always will be, and that the magnitude of its requirements might have reached such a point that there would not have been sufficient leather available to supply the demand, if electricity had not come to help out. Yet it is a fact that electricity, as an agent for the transmission of power, has taken the place of much of the heavy belting. In other words, after doing all it has done to assist the belting industry, it turns around and to a greater extent than any other transmission agent, replaces belting in its own work. Not only that, but it dispenses quite largely with the use of belting in driving, not only dynamos being directly connected, but also many motors with the machines they drive, so that at times power is transmitted without any belting at all. More generally, however, some light belting is used, the transmitting being done by a countershaft or light line shaft driving a group of machines with small belts.

Sawdust System of the Wabash Shops

By Ethan Viall

Everything about the new Wabash shops is thoroughly uptodate, and nothing

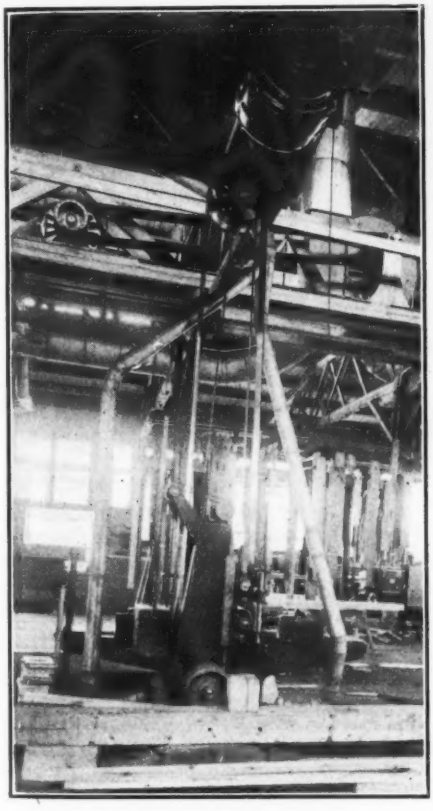


FIG. 3. BLOWER OUTFIT AND A SET OF COLLECTING TUBES

illustrates this more than the complete system in the woodworking shop for the removal of all sawdust and fine shavings. While there is nothing strikingly new about it, yet it is unusually complete and is far more efficient and convenient than many larger plants.

The woodworking shop is next to the

FIG. 2. FEEDING THE SAWDUST TO BOILERS

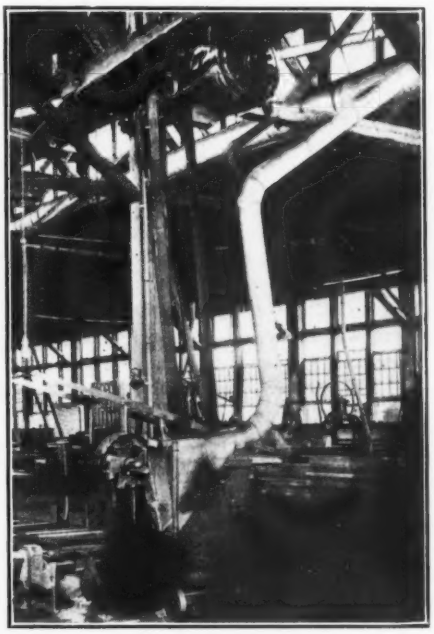


FIG. 4. COLLECTOR FOR ANOTHER TYPE OF MACHINE

power plant, and the large pipe used for shooting the sawdust over to the hopper tank on the roof of the boiler room is shown in Fig. 1. From this hopper the sawdust is either fed into the furnaces through the chutes shown at the left in Fig. 2, or it is stored in the large metal bin on the right, from where it is loaded into cars for use out along the line. A 6-foot blower is used for producing the suction in the collecting tubes and the draft for the conveyer. The blower is shown in the upper part of Fig. 3. The motor used to drive this fan is a 75-horsepower alternating-current machine. This cut also shows the collecting tubes for one of the machines, and also illustrates the method of placing the alternating-current individual motors used throughout the shop. Fig. 4 shows this a little more clearly and also the collector for another type of machine.

With this system the shop is kept remarkably clean and free from dust or dirt of any kind, and every bit of sawdust or fine shavings is put where it will do the most good, with the least trouble.

Tests of Low Grade Fuels in Gas Producers

Among the interesting fuel tests which have been carried on during the past few years by the United States Geological Survey was a series of trials of low-grade fuels in gas producers. These tests indicated that many fuels of such low grade as to be practically valueless for use in boiler furnaces, including slack coal, bone coal, and lignite, may be economically converted into producer gas, and may thus generate sufficient power to render them of high commercial value. Coal containing as much as 45 per cent. ash, and lignites and peats high in moisture, were successfully converted into producer gas, which was used to drive gas engines.

It was found that the low-grade lignites of North Dakota developed as much power when converted into producer gas as did the best West Virginia bituminous coals when utilized under the steam boiler. From this result it would appear that lignite beds underlying from 20,000,000 to 30,000,000 acres of public lands, supposed to have little or no commercial value, probably have a large value for power development.

In the fuel-testing plant, using the best Kanawha Valley coal, the steam plant produced 0.28 horsepower-hour per pound of coal, and the gas plant 0.96 horsepower—3.43 times the efficiency for the producer-gas plant over the steam plant. The remarkable feature in these tests was the comparison between the Kanawha Valley coal under the steam boiler and the lignite in the producer-gas plant. The former under the boiler produced 0.28 horsepower-hour per pound of fuel, while the lignite used in producer-gas plant produced 0.30 horsepower-hour, or 1.07 times the energy per pound of the best steam coal burned in a boiler furnace.

The Lackawanna Steel Company is arranging to operate by Niagara Falls power the quarries which it has leased from the Indians of the Tuscarora reservation, situated in Niagara county, N. Y. Power will be furnished by the Niagara, Lockport & Ontario Power Company, which has secured a franchise for a transmission line across the reservation lands from the Indians.

POWER AND THE ENGINEER

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What Would You Do?

Fully ninety per cent. of the steam plants in the United States are of two hundred horsepower capacity or less. These plants are operated in pretty near all kinds of conditions, by all kinds of engineers, and are owned by men of varied characteristics. Hence, it is not exaggeration to say that many of these plants are in operation when they should be undergoing repairs.

The ignorant engineer has no scruples about operating a boiler in almost any condition, because he does not know any better, and if a serious accident happens it is only what could be expected. On the other hand, there are intelligent engineers who know the danger lurking in a faulty boiler, and also when a boiler is unfit for use, but who will operate it nevertheless.

The general verdict will be that the ignorant engineer should not be permitted to operate, and that the engineer who knows the dangers would not allow such a boiler to be used in his plant. The first is true, but how about the latter? Pressure is brought to bear upon others besides politicians; the engineer finds that this is so, and when it comes to the matter of operating a steam plant that is not in a safe condition, as a matter of "accommodation" he will usually accede to the wishes of his employer.

For instance, a certain firm operated a part of its plant by water power in connection with an electric power plant. An accident happened to a part of the power-plant equipment and a hurried arrangement was made to install an engine direct-connected to a suitable generator in an old boiler room. The engineer was asked to operate the boiler, which was over twenty years old, and at a much higher pressure than it had carried for years. The engineer was familiar with the conditions, and wishing to accommodate (probably in order to hold his job), he consented to run the chance of the boiler holding together until the completed repairs in the power house relieved the make-shift arrangement. What would you have done under the circumstances?

Another engineer took charge of a strange plant. The first time he opened the flue-cap doors he found that the dry-sheet had been burned away close up to the tube head, due to the arches having been permitted to remain in a faulty condition. The boiler had been operated in this manner for a year or more. He knew that the plate had deteriorated, but to what extent was guesswork. He also knew that the former engineer had been operating the boiler in that condition, and so concluded that it would hold together, or at the worst would give some warning of weakness in time to prevent a disaster. He, therefore, continued to operate the boiler. What would you do in such circumstances?

When it comes down to a fine point, there are mighty few engineers who will quit a job because of some defect about the boiler which the owners will not correct. He may view it with apprehension at first, but as time goes on and nothing happens, he begins to feel secure, and it soon becomes a case of familiarity breeding contempt. Another factor which keeps many a man employed in a hazardous occupation is the knowledge that there are helpless ones depending upon him, and with but a few dollars to fall back upon it is no trifling matter to throw up a job when the pay is sure each Saturday, even though there do exist elements of danger that should not. What would you do in such a case?

Economical Compression

"What is economical compression?" is a question that has been often asked, and, like the questions of economical vacuum and proper receiver pressure, it does not seem to be satisfactorily settled. If an engineer starts an investigation with a desire to find facts agreeing with preconceived ideas or prejudices, he will usually get the results he is looking for, whether true or otherwise. If the idea that the momentum of the moving parts of a steam engine must be arrested at the end of the stroke is cherished, compression will be insisted upon without investigating, by analysis or otherwise, whether there be momentum to be absorbed at the end of the stroke. If it is known that the crank pin takes care of pressures and movements at all other parts of the stroke, it will be insisted that if the movement is arrested at the end of the stroke by the crank pin it will be done with a decided and injurious jerk. If it is thought cheaper to run an engine to compress exhaust steam in the clearance space than to fill this space with steam from the boiler, the cubic feet of steam saved in this way per hour will be carefully computed and the cost of running the engine as a compressor part of the time will be neglected. If it is discovered that a longer cutoff and a greater mean effective pressure are the results of compression, initial condensation, which cannot be measured, but which the compression advocate assumes to be greater without than with compression, is claimed to cost more steam than the increased area of the diagram obtained with compression. If friction brought upon shafts and pins is thought of, it is assumed that compression removes this and allows the engine to float past the centers on bearings as near frictionless as human skill can make them. Last but not least is the desirable feature of quiet operation; noise, it is said, costs money. Concede that it does; that does not prevent an intelligent engineer from running an engine quietly without resorting to compression.

Combined Coal and Oil Gas Firing

Demonstrations have recently been made in London, England, to show that by blowing gas from oil over the top of a bituminous-coal fire, smoke would be greatly reduced if not entirely eliminated. It is quite plain that this result should be expected, as it introduces an incandescent blanket over the gases distilled from the coal which prevents their contact with the comparatively cool surfaces of the boiler and the consequent chilling of the gases below the ignition point; it is this chilling which produces smoke instead of flame. It has been shown, however, that the most smoky varieties of bituminous coal may be smokelessly burned by the adoption of a properly constructed furnace having sufficient space beneath the boiler to allow complete combustion of the smoke-forming gases before they can come into contact with the boiler.

In the report of a test of the gasified-oil apparatus, it was stated that by the use of the process not only was all smoke prevented but coal which when burned in the ordinary way would evaporate only six pounds of water per pound of coal would, when burned in conjunction with twelve per cent. of its weight in oil, evaporate ten pounds of water per pound of fuel burned. While it is perfectly clear that complete combustion of coal would show a higher degree of economy than the incomplete combustion, smokeless or otherwise, it looks doubtful that the addition of so small a percentage of perfect fuel to the imperfect would increase its evaporative capacity forty per cent. It is to be expected that a mixture of fuel, one element of which had two and one-half times the heat value of the other, would give a better result than the poorer element burned alone, but it seems probable that more than twelve per cent. of the better fuel would be needed to get a gain of forty per cent. over the poorer fuel alone, if the poorer fuel were handled intelligently.

Prospects of saving so large a percentage should not be neglected, of course, unless the cost of saving equals the amount saved. In the case mentioned, one hundred pounds of coal made six hundred pounds of steam; one hundred and twelve pounds of coal and oil made one thousand pounds of steam. Now the twelve pounds of oil should make two hundred pounds of the one thousand pounds of steam made, showing a net increase in evaporation for the coal of two hundred pounds, or thirty-three per cent. The comparative cost of the two fuels used in this case is not mentioned, but it is probably safe to assume that the oil costs five times as much per pound as the coal, and was only two and one-half times as valuable as a steam maker. In this light, would it pay to install a gasified-oil auxiliary to a coal-burning furnace, and how much would be really saved by such installation, even though all the promises were fulfilled? Improvement in economy in existing power plants will come more frequently in the immediate future from the boiler room than from any other part of the plant, and improved methods of boiler-room practice will be adopted if feasible. Owners and managers, even if not from Missouri, should say to every proposer of new methods, "Show me!"

Something to Work For

It is a demonstrated fact that the majority of men will exert themselves only to the extent necessary to enable them to retain their positions without too much fault finding from their superiors. When it comes to the matter of the economical utilization of the materials used in their work it is almost folly to expect that poorly paid men will bother themselves with such a matter unless their compensation is affected thereby. Such men are commonly satisfied to get along in the easiest manner possible to themselves.

The proverb, "The laborer is worthy of his hire," is not observed in all walks of the industrial world. It is doubtful if any skilled workers are paid lower wages than the majority of firemen who are operating steam boilers, and yet it has been proved over and over again that a careful, painstaking fireman can more than save his wages in almost any ordinary steam plant.

According to a newspaper report the United States Government will have saved $75,000 in the coal consumption of the Atlantic fleet by the time the fleet reaches home from its voyage around the world. This result is made possible by a system of competition amongst the engine-room forces of the various battleships while on a voyage from Hampton Roads to San Francisco whereby a saving of 1500 tons of coal was made on the trip, and the established rate continued across the Pacific. It is understood that the navy department will ask Congress for an appropriation of $2500 for prizes to be distributed among the engineers and firemen of those ships showing special economy in coal consumption.

If competition or rivalry stimulates men to strive for increased fuel economy in the fire room of battleships, why will it not appeal to firemen operating stationary steam boilers? The answer is simple. There is usually no second plant operating under the same conditions as those of any given plant from which data can be obtained, because, in most plants of average size reliable records of the operating details are not kept. How, then, can engineers or firemen be stimulated to do their best to realize the maximum efficiency in the operation of their steam plants? It will never be accomplished by the management giving all the credit of economy to the chief engineer, or by the chief taking all the credit to himself.

Enthusiasm imparted to the fireman may cause him to be especially careful and industrious for a time, but unless there is a greater incentive than this he will naturally suffer a relapse eventually. Not only should every man employed about a steam plant be given credit for what efficiency his particular part of the equipment contributes, but each should be awarded a proportionate share of the saving brought about by his efforts. Under such a working arrangement, each attendant in the plant would naturally be on the outlook for any cause of leakage and any shirking by another in keeping his part of the equipment up to the standard.

It is not necessary to strive to equal the economy obtained in some similar plant. The thing to do is to ascertain the best results that have been obtained from similar equipments, and then determine by a test run how far below such results one's own plant is being operated. If an engine is using a third more steam than it should under ordinary operating conditions, and many of them do, the operating force would be quick to figure out how much extra pay would come to them each week, supposing the management had business sense enough to offer one-half of the cost of fuel saved to the engine- and fire-room forces. It would be a paying proposition in almost any steam plant, except where the highest state of efficiency is already obtained by virtue of a forceful chief who thoroughly understands his work and has unusual executive ability.

Although the turbo-electric drive has been advocated for large liners, it has been left to smaller craft to be the first to adopt the new method of propulsion. The idea of the combination is that a high-speed turbine should be used to drive a high-speed electric generator which in its turn would supply current to slow-speed motors on the propeller shafts. The practicability of the arrangement for ocean steamers has yet to be established, but for the particular service for which the Chicago fire boats are required the arrangement has special advantages. The same turbines serve to drive both generators and centrifugal fire pumps, thus saving special pumping engines. The arrangement is all the better because the boat seldom requires much power for propulsion while actually engaged in pumping. The experiment will be worth watching, although it has not much bearing on the larger problem of the application of the turbine-dynamo-motor drive to ocean steamers.

The National Engineers' Convention

The Twenty-sixth Annual of the N. A. S. E. at Denver a Big Success
Fred J. Fischer, of Los Angeles, Elected President for Coming Year

EXHIBITS ALSO INTERESTING

The twenty-sixth annual convention of the National Association of Stationary Engineers was called to order on Tuesday, September 8, in the Auditorium at Denver, Colo., and formally welcomed to the State by Governor Buchtel and to the city by W. W. Downing, in the absence of the mayor. The responses on the part of the association were made by President Joseph Carney and Vice-President F. J. Fischer. Thomas W. Shears, a well-known engineer and resident of Denver, told of the developments and accomplishments of the association, and was complimented by Past President T. N. Kelsey.

Presentations of a national flag, with a pennant for every State in the Union, by W. T. W. Curl, of Los Angeles, in behalf of No. 2 of that city, and of a silver-mounted gavel by the local association, followed the speaking.

President Carney in his address delivered at the first business session took a sensible stand against the suggestion to have a permanent or paid president. "Sentiment as well as precedent," he said, "demands that your national president be an active operating engineer, and this condition demands that he must labor for someone else, as well as the association." So long as the office can be as satisfactorily filled as it has been in the past from the active membership, and as an honorary position, there is no occasion for any change. He recommended, however, the provision of district presidents to relieve the executive head of the routine work and allow him time for the consideration of some of the weightier problems of the association.

"That apparently trivial incidents have an important bearing in placing our association in an unfavorable light in some minds is exemplified in the recent gain, and almost immediate practical loss, of a most promising association in Pennsylvania. After two years of persistent effort, Deputy Munzinger, of that State, succeeding in organizing a subordinate association at Johnstown, Penn., the membership being recruited almost entirely from the engineers of the steel corporation. No association ever started out with brighter prospects, for the proposal to form the association met with the indorsement of the officials of the company, and their deep interest in the organization they evinced by providing the meeting hall and detailing members of the technical staff to aid in the educational work.

"Starting with less than thirty members, two months saw a membership of nearly ninety, and when Deputy Munzinger, in response to a hasty call, attended the next meeting he found twenty-one candidates in waiting. The call for the deputy was caused by the receipt by the association of the printed blank with proposed amendments to our constitution, and noting therein a proposal to change our preamble by eliminating the salient features that so clearly distinguish this association from other organizations of stationary engineers, the support of the officials of the company was immediately withdrawn, and though Brother Munzinger strove hard to prevent it, the defection of all but a handful of the members followed. The charter is retained by those members not employed by the steel corporation, and it is problematical as to the future of the association; while we cannot, at least for some time to come, hope for a renewal of the support of the company officials, without which no organization of their engineers can be effected.

"Here and now this association should emphasize its purpose to uphold and maintain, unaltered, the preamble and all it implies, and make it clear to those who seek to change it that their efforts are not possible of accomplishment."

The report of the secretary showed the total number of members paying per capita taxes to be 19,607, as against 19,465 a year ago.

The finances were in good condition, but the delegates could not resist the temptation to pay themselves a four-cent mileage, practically depleting the treasury. The mileage, as voted, involved the expenditure of $19,139.60 for this purpose.

The license committee reported that since the adjournment of the last national convention the following changes and additions have occurred:

1. Scranton, Penn. A license and boiler inspection ordinance. The inspector is a member of the N. A. S. E.

2. Hoboken, N. J. Change in former ordinance. Examining board increased from three to five members.

3. Jersey City, N. J. Ordinance put into force. Though contested, it has been upheld by the city courts. Results are very satisfactory.

4. Rhode Island. A very good bill was presented at the last session of the legislature, but failed to pass.

5. Oklahoma City, Okla. Municipal ordinance. Examiners appointed by the mayor. Examiners to receive as compensation $100 per annum.

6. Tacoma, Wash. Minor changes in ordinance, February 1, 1908.

7. Ohio. Minor changes, including increase in number of district examiners, and increasing salaries of latter.

8. Minnesota. Letters received indicate considerable dissatisfaction relative to enforcement of State law.

9. St. Louis, Mo. Affairs seem to be in the same condition as indicated in No. 8.

10. Maine. Has a law covering public builders. Examiners elected by the people.

11. Seattle, Wash. Change in ordinance, providing compensation for examiners.

The election of officers for the ensuing year resulted as follows:

President, Fred J. Fischer, of Los Angeles, Cal.; vice-president, William J. Reynolds, of Hoboken, N. J.; secretary, F. W. Raven, of Chicago, Ill.; treasurer, Samuel B. Forse, of Pittsburg, Penn.; trustee of the national organ, James H. Van Arsdale, of St. Louis, Mo.; conductor, Thomas H. Cole, of Brooklyn, N. Y.; doorkeeper, G. H. Kendrick, of Little Rock, Ark.

The retiring president, Joseph Carney, of New York, was presented a handsome set of silver and cut glass.

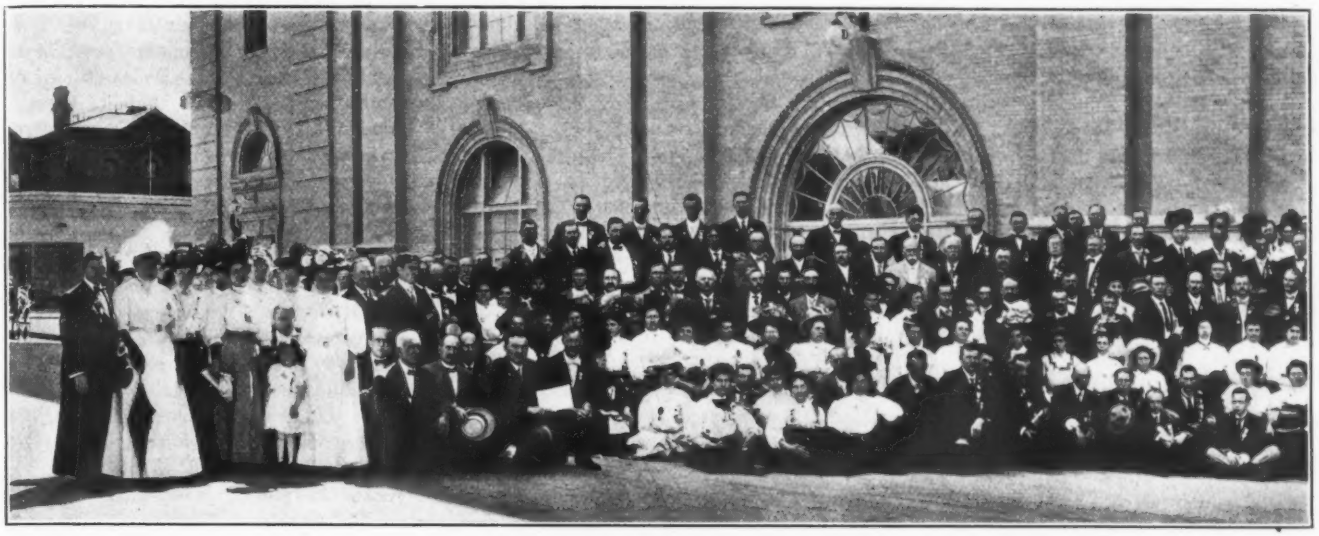
The social features of the convention consisted of an informal reception at the Albany, the headquarters, on Monday evening; formal opening of the exhibitors' association display on Tuesday evening; an excursion to Silver Plume on Wednesday; a theater party on Thursday and a ball on Friday evening, with automobile rides, etc., for the ladies. Many of the delegates went to Cripple Creek on Saturday and were entertained by the local association.

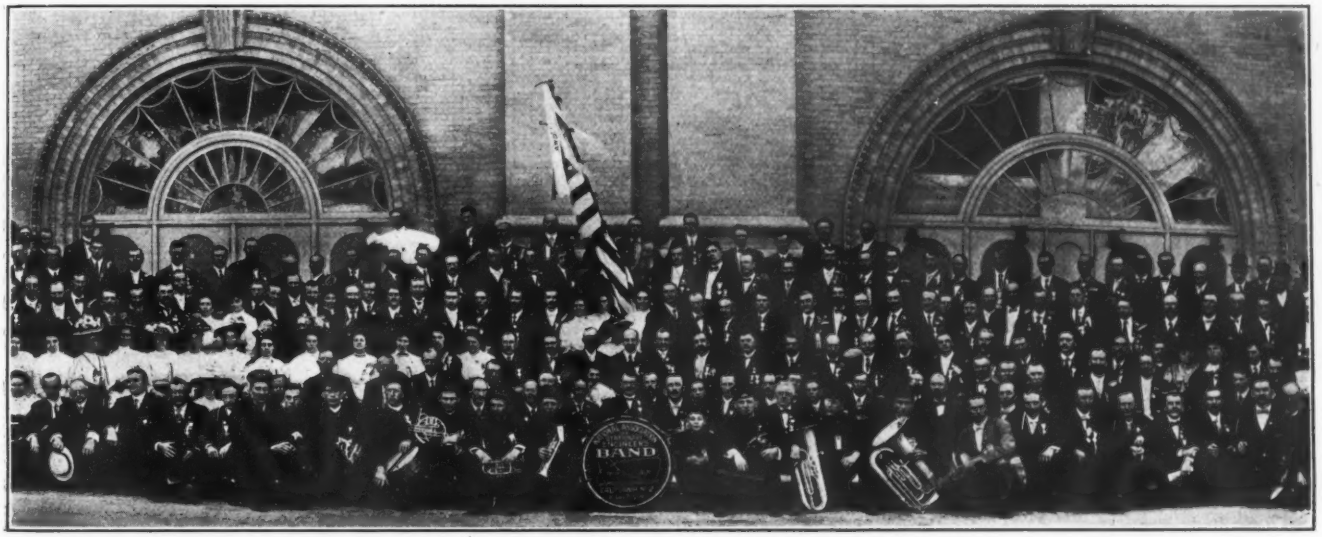
The life and accident association elected James G. Beckerleg as chairman of the board of trustees, and Ira Watts as secretary and treasurer; T. N. Kelsey was elected trustee for a full term, and P. E. Leahy to fill the unexpired term of M. D. Nagle, deceased.

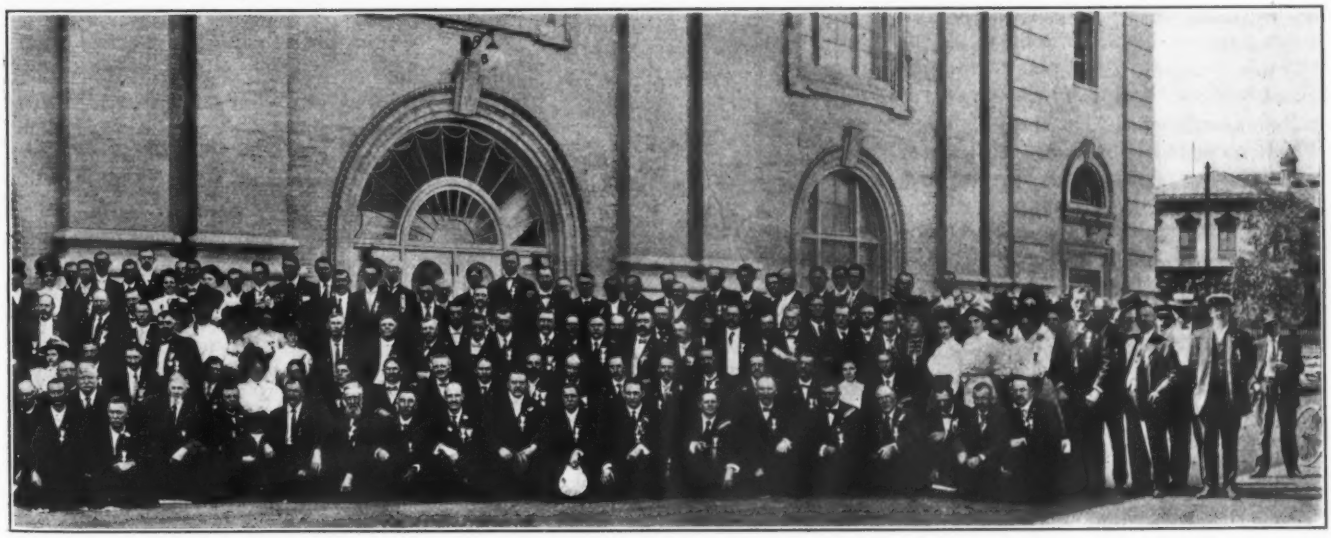
The Exhibitors' Association

The exhibition held in connection with

the convention was one of the best which has been got together. The facilities afforded by the conditions under which the Denver convention was held were such as to afford ample opportunity to the participants and the result was creditable to the







A GROUP OF DELEGATES AND GUESTS AT THE DENVER CONVENTION OF THE NATIONAL ASSOCIATION OF STATIONARY ENGINEERS

exhibitors and interesting to the delegates. The following firms and companies were represented:

American Flue Blower Company, St. Louis, Mo. Represented by J. J. McLean.

Arrow Boiler Compound Company, St. Louis, Mo. Represented by E. M. Swindler.

Austin Separator Company, Detroit, Mich. Represented by H. H. Humphries.

American Steel and Wire Company, Chicago, New York, Denver. Represented

by E. R. Poole, manager of the Denver office; G. H. Williams, Denver office; A. T. Merriman, Chicago office.

Ashton Valve Company, Boston, Mass. Represented by Hampson-Fielding Engineering Company, Denver, and Columbus Dill, of Boston.

Allis-Chalmers Company, Milwaukee, Wis. Represented by R. D. Tomlinson and R. B. McConney, of Denver.

American Steam Gauge and Valve Manufacturing Company, Boston, Mass. Represented by W. R. Ladewig, of Chicago.

American Injector Company, Detroit, Mich. Represented by Morse Brothers, of Denver, and John Trix.

Atlas Preservative Company of America, Belleville, N. J., and 30 Broad street, New York. Represented by Jacob C. Ludwig.

American Well Works, Aurora, Ill. Represented by Morse Brothers, of Denver.

American Cork Lid Company, Denver, Colo. Represented by Otto W. Michelfelder and George L. Vail.

Buckeye Engine Company, Salem, O. Represented by C. B. Hunt and W. Radkey, of Salem, and by H. L. Vaughn, of Denver.

Babcock & Wilcox Company, New York. Represented by the Onderdonk Engineering Company, of Denver, and A. H. Nelson.

Burt Manufacturing Company, Akron, O. Represented by Morse Brothers, of Denver.

Burnite-Leonard Engineering Company, Denver.

British American Chemical Company, Paterson, N. J.

Chapman Valve Manufacturing Company, Indian Orchard, Mass. Represented by H. E. Stone, of Pittsburg, and W. L. Buss, of Chicago.

Cadman Manufacturing Company, A. W., Pittsburg, Penn. Represented by A. W. Cadman.

Crane Company, Chicago, Ill. Represented by F. W. Knapp, of Denver.

Chase Engineering Company, Mattoon, Ill. Represented by Hendrie & Bolthoff Manufacturing Company, of Denver.

Chicago Pneumatic Tool Company, Chicago, Ill. Represented by Morse Brothers Machinery and Supply Company.

Cancos Manufacturing Company, Philadelphia, Penn. Represented by H. Harmstad.

Carey Manufacturing Company, The Philip, Lockland, O. Represented by E. H. Muller, of Denver.

Concrete Cement and Plaster Company, Denver, Colo.

Canedy-Otto Manufacturing Company, Chicago Heights, Ill. Represented by Morse Brothers Machinery and Supply Company.

Cling-Surface Company, Buffalo, N. Y. Represented by Wm. D. Young.

Carpenter & Co., Geo. B., Chicago, Ill. Represented by Dan Cubberly, of Denver, and by Chas. Reedy, of Minneapolis.

Chesterton Company, A. W., Boston, Mass. Represented by W. M. Rae.

Crandall Packing Company, Palmyra, N. Y. Represented by B. M. Knobel and Mrs. Knoebel, of Chicago.

Cook's Sons, Adam, New York. Represented by Silas C. Cook.

Dearborn Drug and Chemical Works, Chicago, Ill. Represented by Grant W. Spear, Vice-President Delaney, of Cincinnati, Cain and V. R. Hughes, of Denver, Beckerleg, Chicago, and E. W. Ward, of Milwaukee.

Davis Regulator Company, G. M., Chicago, Ill. Represented by M. D. Neely and J. C. Kinsley.

Detroit Lubricator Company, Detroit, Mich. Represented by A. D. Howard and C. C. Baguell, of Detroit.

Disston & Sons, Inc., Henry, Philadelphia, Penn. Represented by Morse Brothers, of Denver.

Electrical Record, The, New York. Represented by J. M. Walton and D. J. McCann.

Foster Engineering Company, Newark, N. J. Represented by the Onderdonk Engineering Company, of Denver.

France Packing Company, Tacony, Philadelphia, Penn. Represented by A. W. France.

General Electric Company, Schenectady, N. Y. Represented by W. W. Torrence and J. B. Ambler, of Denver.

Green Engineering Company, Chicago, Ill. Represented by A. B. Kennedy, of Denver.

Gandy Belting Company, Baltimore, Md. Represented by Chas. H. Dankmeyer.

Goulds Manufacturing Company, Seneca Falls, N. Y. Represented by Morse Brothers, of Denver.

Garden City Fan Company, Chicago, Ill. Represented by Morse Brothers, of Denver.

Griscom Spencer Company, New York. Represented by J. B. Spencer, of New York, and Morse Brothers, of Denver.

Garlock Packing Company, Palmyra. N. Y. Represented by J. T. Potts, of San Francisco; M. H. Mickey, Denver; C. V. Patterson, Denver and San Francisco; C. A. Baruhart, Mexico; F. W. Wells, Salt Lake City.

Greene, Tweed & Co., New York. Represented by F. E. Ransley and B. M. Buckley, of New York.

Harris Pump Company, Indianapolis, Ind. Represented by A. B. Kennedy, of Denver.

Hendrie & Bolthoff Manufacturing and Supply Company, of Denver, occupied eight booths and represented a number of prominent manufacturers of the East.

Heine Safety Boiler Company, St. Louis, Mo. Represented by A. B. Kennedy, of Denver.

Hills, McCanna Company, Chicago, Ill. Represented by Robert Hills, president, and Thomas Delany, both of Chicago.

Hawkeye Compound Company, Chicago, Ill. Represented by H. E. Tibbles and W. F. Ebert, of Chicago; J. E. Allen, Denver; Glen Deyo, of Omaha.

Home Rubber Company, Trenton, N. J. Represented by H. B. Chandler and Morse Bros., of Denver, and Dick Foley, of Trenton.

Ingersoll-Rand Company, New York. Represented by A. B. Kennedy, Denver.

International Correspondence Schools, Scranton, Penn. Represented by J. D. Jones, Scranton, and W. S. Broderick, Denver.

Ide & Sons, A. L., Springfield, Ill. Represented by A. B. Kennedy, Denver.

Johns-Manville Company, Milwaukee, Wis., and New York. Represented by S. M. Hildreth.

Jones Underfeed Stoker Company of America, Chicago, Ill. Represented by Gilbert Wickes & Co.

Jenkins Brothers, New York. Represented by Charles J. Jackson, of Chicago; Frank Martin, William G. Le Compte and "Billie" Murray, of New York; W. J. Brown, Denver.

Keystone Lubricating Company, Philadelphia, Penn. Represented by C. N. Hopper, Philadelphia; J. H. Campbell, Chicago; M. B. Urgnhart, Denver, and Herbert Self, of New York.

Kent Lubricating Company, Waukesha, Wis. Represented by L. H. Kent, treasurer.

Kansas City Machinery Works, Kansas City, Mo.

Kieley Steam Specialty Company, New York and Chicago. Represented by Howard H. Fielding.

Locke Insulator Manufacturing Company, Victor, N. Y. Represented by Hendrie & Bolthoff Manufacturing and Supply Company, of Denver.

Liberty Manufacturing Company, Pittsburg, Penn. Represented by C. A. Com, traveling sales agent; C. J. Carle, vice-president; W. H. Hill, of Denver.

Leschen & Sons Rope Company, St. Louis, New York, Chicago and Denver.

Lord & Co., G. W., Philadelphia, Penn. Represented by Albert A. Kitto, Pueblo, Colo.; Oswald L. Keen, Denver; Edward McCarthy, Philadelphia.

Lagonda Manufacturing Company, Springfield, O., occupied four booths and was represented by H. F. Weinland, M. M. Seelers and Pat Malloy, of Springfield, O.

Lunkenheimer Company, Cincinnati, O. Represented by B. T. Delafield.

Murray Iron Works, Burlington, Iowa., exhibited a 10x12 Corliss engine, built especially for the convention.

McLeod & Henry Company, Troy, N. Y. Represented by John H. Foote and A. H. Schoembeck.

Mason Regulator Company, Boston, Mass. Represented by F. A. Morrison and Eldon MacLeod.

Monarch Steam Blower Company, Troy, N. Y. Represented by J. Frank

Lanning, of Pittsburg; G. R. Sanford and the Denver Engineering Specialty Company.

McCrea & Co., James, Ghicago, Ill. Represented by M. B. Skinner, of Chicago, and L. W. Naylor, of Denver.

Michigan Lubricator Company, Detroit, Mich. Represented by W. E. Bryant, vice-president.

Mining World, The, Chicago, Ill. Represented by Jack Holman and Mr. Scott.

National Engineer, The, Chicago, Ill. Represented by S. J. Hamilton; J. Lane and F. S. Kenfield.

New York Belting & Packing Company, New York. Represented by Thos. H. Dickinson and the Hendrie & Bolthoff Manufacturing and Supply Company.

Nernst Lamp Company, Pittsburg, Penn. Represented by R. D. Marthens and C. M. Wright, of Denver.

National Steam Pump Company, Upper Sandusky, O. Represented by Morse Brothers, of Denver.

Nixon-Lancaster Engineering Company, Denver, occupied two booths and was represented by Geo. L. Vail.

Ohio Blower Company, Cleveland, O. Represented by the Nixon-Lancaster Engineering Company, of Denver.

POWER AND THE ENGINEER, New York Represented by John A. Hill, Fred R. Low, Jack Armour, S. Kirlin, J. M. Watson, W. C. Bullen, F. J. Schweitzer and A. J. Bamford.

Philadelphia Lubricator & Manufacturing Company, Philadelphia, Penn.

Practical Engineer, The, Chicago, Ill. Represented by E. R. Shaw, of New York, and A. L. Rice, of Chicago.

Powell Company, The Wm., Cincinnati, O. Represented by Chas. E. McFarland, vice-president, Randall McFarland, and Bert Rowe, Western agent.

Peerless Rubber Manufacturing Company, New York. Represented by Frank Hardy and Stephen Roberts, of New York; Dan Cubberly, of Denver, and Chas. Reedy, of Minneapolis.

Pilley Packing & Flue Brush Manufacturing Company, St. Louis, Mo. Represented by L. B. Shultz and M. E. Briggs.

Quaker City Rubber Company, Philadelphia, Penn. Represented by W. D. Purcell, of Philadelphia, and Geo. W. Stolle, Denver.

Roebling Sons Company, John A., Trenton, N. J. Represented by J. H. Wilson, of Chicago; J. Mac. G. King and A. L. Seaman, of Trenton.

Revere Rubber Company, Boston, Mass. Represented by W. D. Rigdon, of Boston; S. F. Denny, Chicago, and W. J. Spencer, Denver.

Reed Manufacturing Company, Erie, Penn. Represented by Morse Brothers, Denver.

Reeves Pulley Company, Columbus, Ind. Represented by Morse Brothers, Denver.

Ryerson & Son, Jos. T., Chicago, Ill. Represented by J. T. Corbett.

Sight Feed Oil Pump Company, Milwaukee, Wis. Represented by W. E. Richardson and by the Nixon-Lancaster Engineering Company, of Denver.

Ridgway Dynamo and Engine Company, Ridgway, Penn. Represented by Lindrooth Shubart & Co., Denver.

Strong, Carlisle & Hammond Company, Cleveland, O. Represented by Homer Whelpley, Cleveland, O.

Stearns Rogers Manufacturing Company, Denver. Represented by Henry L. Wilson and A. B. Kennedy.

Southern Engineer, The, Atlanta, Ga. Represented by J. Willett Smith, vice-president; R. W. Larkin, C. W. Cushion and G. Maas.

Steam. The Gage Publishing Company, New York. Represented by John M. Walton and David J. McCann.

United States Graphite Company, Saginaw, Mich. Represented by W. F. O'Hara, Denver.

Vail Ice Making Machinery Company, Geo. L., Denver. Represented by the Nixon-Lancaster Engineering Company.

Walton & Co., F. S., Philadelphia, Penn. Represented by P. F. Rielly and James McDevitt.

Wright Manufacturing Company, Detroit, Mich. Represented by H. H. Humphreys.

Williams Valve Company, The D. T., Cincinnati, O. Represented by C. K. Thomas, New York.

Warren Webster & Co., Camden, N. J. Represented by Howard & Fielding.

Wheeler Condenser and Engineering Company, Carteret, N. J. Represented by A. B. Kennedy, Denver.

Williams Gage Company, Pittsburg, Penn. Represented by A. B. Kennedy, Denver.

Westinghouse Air Brake Company, Pittsburg, Penn. Represented by F. A. Hedendahl, F. Arnsworth, F. P. Livingston, of Denver, and M. H. Burchard, of Chicago.

Westinghouse Electric & Manufacturing Company, Pittsburg, Penn. Represented by L. M. Cargo.

Westinghouse Machine Company, Pittsburg, Penn. Represented by N. F. Richardson, Denver.

The National Exhibitors' Association elected the following officers:

President, Herbert E. Stone, of the Chapman Valve Manufacturing Company, Indian Orchard, Mass.; vice-president, William G. Le Compte, of Jenkins Bros., New York; secretary, W. D. Purcell, of the Quaker City Rubber Company, Philadelphia, Penn.; treasurer, M. B. Skinner, of James McCrea & Co., Chicago, Ill. The new executive committee consists of Edward McCarthy, of the George W. Lord Company, Philadelphia, Penn.; Walter Rigdon, of the Revere Rubber Company, Boston, Mass.; Herbert Self, of the Keystone Lubricating Company, Philadelphia.

Gas Power for Small Plants

By H. B. MESSENGER

Regarding the subject of gas-producer plants, we are told, on the one hand, that the majority of such installations are failures, and on the other, that they are highly successful, and are wonders in economy and ease of operation.

My own experience was with a plant requiring about 75 horsepower, and in direct competition with a water mill. The rapid rise in the price of all sorts of lumber made cord wood, a very cheap fuel when the mill was built, higher than coal, although the distance from the coalfields made that necessary article quite expensive. Fuel bills soon climbed to several dollars per day, the plant was not large enough to make compounding and condensing, with a competent engineer in charge, profitable. The fuel bill was taking nearly all the profits, and something had to be done. Producer gas became a matter of vital interest.

Fortunately my business carried me over quite a large territory last winter, and exceptional opportunities were offered to investigate in several cities and towns without going especially for that purpose, and as a result a producer-gas engine was selected which was built within less than 200 miles of the place where it was to be installed, and a producer which was recommended by the engine builder, who had no producer of his own. This was considered a good arrangement, as there are numerous advantages in getting an engine near home, saving in freight, cost of installation, convenience in case of needing changes, extra parts, repairs, etc., while it seemed evident that the engine builder would have some experience with various makes of producers and would certainly recommend one which would enable his engine to do its work as satisfactorily as possible.

The results have justified the choice. A heavy, well built engine, with ample margin allowed in the rating to enable it to give the full amount of power guaranteed under any conditions, and a producer, also of ample capacity, and so nearly automatic in action as to require no care whatever except the necessary cleaning of the fire once each day, and filling with coal, was installed. The various guarantees as to power, ease of operation, and economy of coal consumption are easily carried out, and it is plain from the work of this plant that steam power for plants of this size and character is a back number, and will not maintain its present supremacy any longer than it takes the power-buying public to learn the advantages of producer gas for certain purposes.

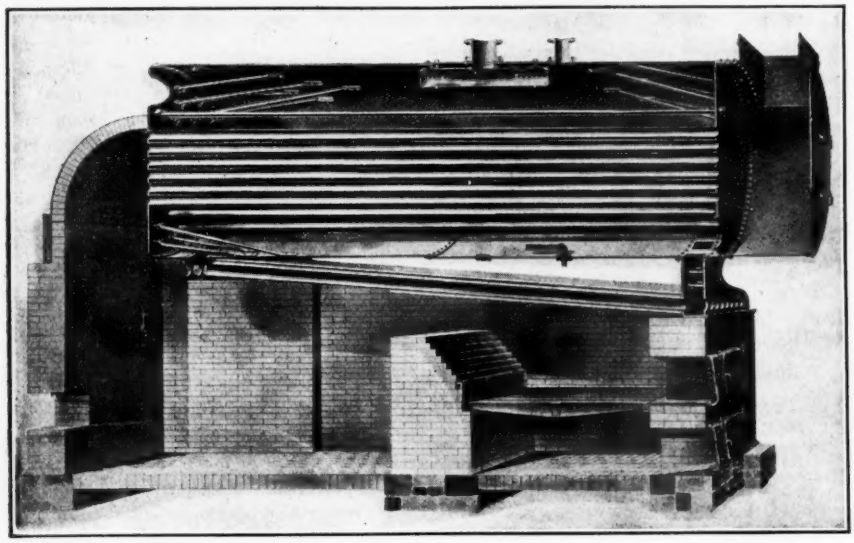
Power Plant Machinery and Appliances

Original Descriptions of Power Devices
No Manufacturers' Cuts or Write-ups Used

MUST BE NEW OR INTERESTING

Lyons Safety Boiler

As clearly shown by the illustration herewith, the Lyons safety boiler is a combination of the return-tubular and water-tube types, the water-tube portion being the lower section. The tubes are fitted into headers or saddles, which are riveted to the boiler shell and openings are provided in the shell to permit circulation.



LYONS SAFETY BOILER

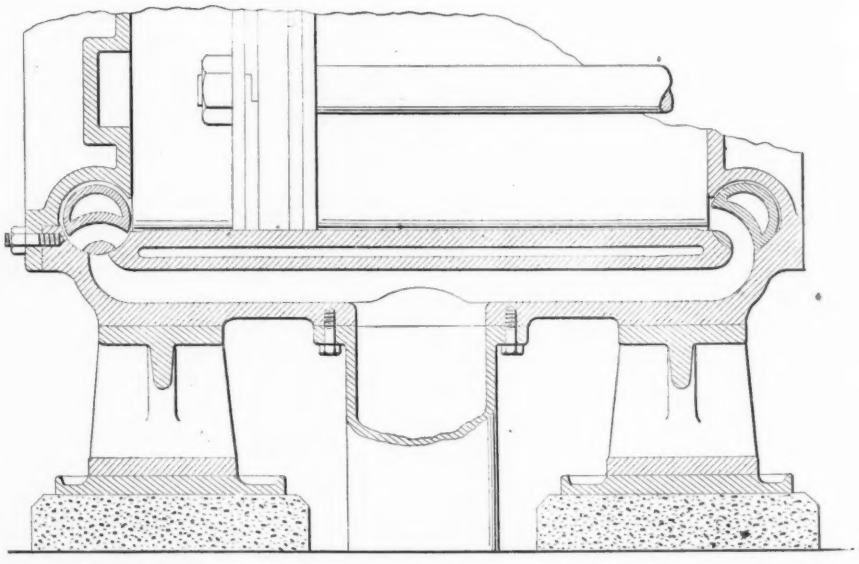
The water-tube headers are provided with hand openings in the outer walls directly opposite the tube openings in the inner walls of the headers. The rear header is made shorter than the front one, in order to give an incline to the water tubes which connect the headers when the shell is set level. These headers or saddles are stayed when necessary with either internal tie bars or stay bolts, and are tested at 400 pounds water pressure before being riveted to the boiler shell. The rear saddle is fitted with plugs, but it is not necessary to remove them when washing the boiler, as the water tubes may be flushed from the shell through the openings leading into the saddle, or from the end handholes.

The boiler when being set is supported by four columns, the rear columns being set in such position that the side walls will inclose them. The side walls then extend back to the rear end of the boiler and the metal rear extensions rest on this rear wall. These columns are made with only one lug and turned so as to form the rear buck stay, or used in a semi-circular rear extension where available floor space demands. The side walls of the setting are carried to a point higher than the water tubes merely to have each course of bricks in a horizontal line. The walls may be stopped about 6 inches above the bottom of the saddles if desired, either by inclining each course of brick, or by "setting off" to correspond with the slant of the water tubes.

The illustration shows the arrangement to control the travel of water and gas. The water tubes are covered with tile or split brick over which it is customary to place two rows of ¼-inch asbestos mill board and a coating of asbestos cement. This arrangement directs the gases to the rear and protects the boiler shell from burning, the tile or brick forming a roof for the furnace. This boiler is manufactured by the Lyons Boiler Works, DePere, Wis.

An Improved Corliss Exhaust Valve

The illustration herewith shows the arrangement and construction of a new Corliss exhaust valve by which the clearance is said to be reduced to a considerable extent, and in a simple and practical manner. This has been accomplished by raising the center line of the valve above the counterbore, and constructing the valve to fill the entire valve chamber and also by forming the cylinder head over the valve, as shown.



DUGAR IMPROVED CORLISS VALVE

The valve is of the screw-driver-driven type and requires but one blade, and the upper half of the valve is cored out to reduce the weight. It is internally ported and between the convex side of the curved port and the outside of the valve is left

a rigid bar somewhat wider than the opening in the exhaust passage. This bar in connection with the lips on either side of the port, furnishes two points of closure against the escape of pressure.

The curve of the internal port in the valve is designed to form with the exhaust passage, when the valve is open, a liberal outlet for the steam that is free from sharp bends, corners or other obstructions. The entire wearing surface is below the center line and by its construction the valve is continually fitting itself to its seat, rendering unnecessary the use of springs or other devices for keeping the valve firmly seated. When it is necessary to remove the cylinder head, the back bonnet is taken off and the valve drawn partly out.

This valve was invented by Edelbert Dugar, Worcester, Mass.

"Sarco" Feed Water Analyzer

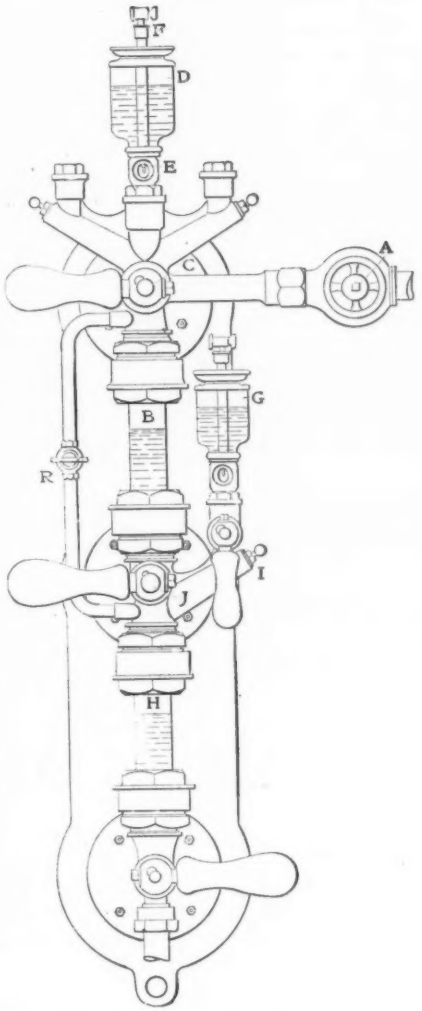
Soda is not a new agent for softening feed water, but its success has been somewhat retarded because the soda has either not been added in the right quantities, or else the temperature of the water was not sufficiently high. It is claimed that by the use of the "Sarco" feed-water analyzer these two drawbacks to the use of soda are entirely removed.

It is claimed for this device that it serves to determine at any time, and in a few moments, in a manner which is so simple that it can be carried out by anyone, the exact quantity of soda necessary from day to day to keep a boiler free from scale. The apparatus is erected in the boiler house or engine room, in fairly close proximity to the boiler. A permanent connection is made to the lower end of the water gage, and a ½-inch pipe run to the analyzer, the connection being there made to the cock *A* shown in the accompanying illustration.

When it is desired to make an analysis of the water in the boiler, in order to ascertain whether the correct quantity of soda is being added, a certain number of drops of a special reagent are first admitted into glass *B* through the two-way cock *C*, set accordingly; the reagent being contained in the receptacle *D*, whose outlet *E* is controlled by the thumb screw *F*. The number of drops may be easily counted at *E*.

The position of cock *C* is next reversed, so that the passage from *D* is closed, and the water inlet opened. Cock *A* is then turned on carefully, and a sample of feed water admitted to the glass *B*, filling it to the mark thereon. The water will be colored by the reagent contained in the glass.

Then, the prescribed number of drops of a second reagent, which is contained in the receptacle *G*, is admitted into the lower glass *H*, through cocks *I* and *J*. The position of the latter is now reversed, the air vent *R* is opened, and the sample of water passes down into glass *H*. Here the second reagent destroys the color-reaction previously produced. The number of drops required to bring about this result shows whether the correct quantity of soda was contained in the sample and, therefore, in the water in the boiler. Until this has been determined, the tests are made twice daily; later it will be found sufficient to make an analysis two or three times a week. With the instrument is supplied a special form of salinometer, which shows when each boiler should be blown off.



"SARCO" FEED-WATER ANALYZER

The apparatus is marketed in the United States by the Sarco Fuel Saving and Engineering Company, West street building, New York City.

In warming up a jacketed engine, be careful to put steam on the jacket first, or unequal expansion may crack something.

Leaks, no matter how slight, should be repaired immediately, otherwise they will become worse and cause corrosion and grooving.

Inquiries

Questions are not answered unless they are of general interest and are accompanied by the name and address of the inquirer.

Effect of Unsymmetrical Field Magnet

A six-pole dynamo had one field-magnet coil damaged; it was operated temporarily with that coil simply short-circuited, but sparked badly at the brushes. Why?

J. T. M.

Because the magnetic fields in the air-gaps were of unequal strengths, due to the absence of a magnetizing winding on the one pole, this pole being weaker at the face than each of the remaining five.

Danger to a Signal Line from Lightning

A signaling line 2000 feet long is a complete metallic (two-wire) circuit, with no connection to the ground. Is such a line liable to disturbances from lightning, and if so, would the liability be diminished by changing it to a grounded circuit?

R. A. L.

Yes; any overhead line is subject to lightning troubles. Changing to a grounded circuit would increase the liability instead of decreasing it.

Ignition Timing in Gas Engines

Does a high-speed gas engine require different ignition timing from that which gives good results in a slow-speed engine?

T. N. J. A.

Usually, yes. To get the best results in both cases the ignition gear of a high-speed engine should operate earlier (have more "advance") than that of a slow-speed engine in order to give the mixture sufficient time to become fully ignited at the proper point of the crank travel.

Ringing Bells from a Lighting Circuit

How can an ordinary electric bell be operated by current from a 110-volt direct-current line without causing trouble?

C. M. K.

Connect the bell circuit in series with three or four 110-volt incandescent lamps, if the bell magnet is wound with fairly small wire. If not, connect the 110-volt lamp and one 6-volt lamp in series with each other and connect the bell circuit permanently in parallel with the 6-volt lamp. To ring, close the circuit between the lamps and the supply line.

Testing a Damaged Field-magnet Coil

A voltmeter applied to the terminals of one coil of a motor field-magnet winding shows no deflection, when the winding is connected to the busbars. Does this indicate a complete or a partial short-circuit, and if partial, is there any instrument that will indicate in what part of the coil the damage lies?

C. H. B.

If your voltmeter needle really gives no deflection whatever, the entire coil is dead

short-circuited. There is no instrument that will indicate the exact or even approximate locality of an internal short-circuit or other damage. Completely rewinding the coil is the only recourse.

Timed Lubrication of Gas Engines

What is meant by "timed lubrication" in speaking of gas engines, and why is it used?

C. M. M.

Timed lubrication is the delivery of oil to the interior of the cylinder in momentary impulses which are timed so that the oil enters the cylinder at exactly the instants when the piston is over the delivery holes. It is employed chiefly in order to economize in oil, but has the additional advantage of avoiding the carbonization of oil in the cylinder, which would greatly increase the fouling of valve seats and igniter points.

Ability of a Steam Pump under Stated Pressures

At an examination I was asked: "A pump has a steam-piston area of 226 inches and a water-piston area of 60 inches. At a steam pressure of 90 pounds what pressure would it pump against, allowing 33 per cent. for friction of water and pump?" Will you answer it for me?

F. C. J.

The area of the steam piston multiplied by the steam pressure and divided by the area of the water piston will give the pressure in the water cylinder. Deducting the friction will give the pressure the pump will work against. Thus

$$226 \times 90 = 20{,}340,\ 20{,}340 \div 60 = 305.66,$$
$$305.66 \times 0.33 = 40.86,\ 305.66 - 40.86 = 254.80,$$

the pressure the pump will work against.

Manhole Reinforcing Ring

Please give a rule for finding the width of reinforcing ring for manhole 11x15 inches, using arithmetic.

J. A. B.

Square the short diameter of the hole and add six times the product of the two diameters; to this add the square of the long diameter and extract the square root of the sum. From the root thus obtained subtract the sum of the two diameters and divide by 4 for the width of the ring. The operation is performed as follows:

$$11 \times 11 = 121;\ 11 \times 15 \times 6 = 990;$$
$$15 \times 15 = 225;\ 121 + 990 + 225 = 1336;\ \sqrt{1336} = 36.551;\ 11 + 15 = 26;\ 36.551 - 26 = 10.551;$$
$$\frac{10{,}551}{4} = 2.637.$$

Practically $2\frac{1}{8}$ inches.

High Vacuum in Turbines and Engines

1. Why is very high vacuum more important in a steam turbine than in a reciprocating engine?

2. What is the conceded gain in economy by a turbine due to increasing the vacuum above 26 inches?

S. S. C.

1. Because there is more gain in economy due to high vacuum in the turbine than in the engine. The turbine expands steam down to condenser pressure, so that any decrease in that pressure extends the expansion range by just that much, and a turbine-expansion diagram is much longer on the base, relatively, than the indicator diagram of an engine, because an engine capable of expanding to condenser pressure would be uncommercially large and expensive. Consequently any addition to the bottom of a turbine-expansion diagram will have a larger area than an equal downward addition to the indicator diagram of a piston engine; moreover, the added area will be a larger proportion of the original diagram in the case of the turbine than in that of the engine.

2. From 3 to 5 per cent. per inch of vacuum, up to about 28½ inches.

Personal

C. L. de Muralt has been re-appointed professor of electrical engineering at the University of Michigan for the coming year. During the winter semester Professor Muralt will devote his attention to the consideration of the more general aspects of applied electricity. The course of lectures will include the discussion of the characteristics and application of alternating- and direct-current motors, the design, construction and operation of electric plants, the principles and methods of transmitting, distributing and controlling alternating currents, the calculation and operation of electric railways and the management of electric properties, with special references to the commercial aspects of electrical engineering.

Business Items

F. E. Ransley, of Greene, Tweed & Co., of New York, at the close of the Denver convention, went on an extensive Western trip, as far as Vancouver.

J. B. Spencer, of the Griscom-Spencer Company, of New York, reports excellent results after an extensive Western trip. He says the mines are very poorly equipped with heaters and separators, and there is a good field in which to work.

In the advertisement of the American Boiler Economy Company, on page 68 of the issue of September 15, the engraving of the regulator was printed upside down. We feel sure any of our readers would readily detect the very apparent error.

The Erwood positive duplex blowoff valve, made by John Erwood, 1604 West Adams street, Chicago, Ill., is meeting with much success. The nonwiredrawing feature is regarded quite highly by engineers. It is said to be the only crucible-steel blowoff valve in the market.

William M. Davis has opened an office at 95 Broad street, Boston, Mass., to conduct a business as lubrication engineer. Mr. Davis has had more than fifteen years' experience as a specialist in all that pertains to practical and scientific management of lubrication costs in industrial establishments.

The Morigrieve Engineering Company, with offices at 100 William street, New York, and at Perth Amboy, N. J., has been formed for the manufacture of automatic engine stops, safety devices for jet condensers and a new elastic metallic packing. It will also conduct a general engineering business. The officers of the company are T. Grieve, president; J. Morrisey, secretary and treasurer; R. Henderson, vice-president and consulting engineer.

The Buckeye Boiler Skimmer Company, South End, Toledo, Ohio, has received a letter from the France Company, Bloomville, Ohio, in which it says: "With reference to our experience with the Buckeye automatic boiler cleaner we wish to state that we have had your skimmers in service at all our crushing plants during the last few years, and the results obtained from their usage are very satisfactory. We operate them several times a day and thus remove the scale and other sediment before it has had time to adhere to the boiler."

The Industrial Power Company, of Milwaukee, manufacturer of the Atkinson automatic gas producers, has been sold to a recently organized Wisconsin corporation called the Industrial Gas Power Company, with offices 621 and 622 Caswell block. The officers of the new company are W. O. Jones, president and treasurer; C. J. Atkinson, vice-president, and H. K. Cowen, assistant treasurer and secretary. Mr. Jones was for a number of years vice-president and purchasing agent of the Plano Manufacturing Company, and after the organization of the International Harvester Company, of which the Plano concern was one of the original five constituent companies, he was made general manager of the purchasing department. Both Messrs. Atkinson and Cowen have been connected with the Industrial Power Company since its organization. The Industrial Gas Power Company will continue to manufacture the Atkinson gas producers.

New Equipment

Anson A. Potter, Gouverneur, N. Y., is interested in a plan to build an electric railway to be about 100 miles long.

M. M. Smith, president of the People's Bank, Sanford, Fla., has applied for franchise to establish an electric-light plant.

It is reported that the People's Ice and Coal Company, Omaha, Neb., will erect an ice plant of 350 tons daily capacity.

Robert Crowe, of Arkadelphia, Ark., has asked for a franchise to erect and operate an electric-light plant in Nashville, Ark.

The Brunswick (Maine) Electric Light and Power Company has awarded contract for the construction of its power house.

The Tryon (N. C.) Electric Light, Water and Power Company, is planning the construction of an electric-light plant, it is said.

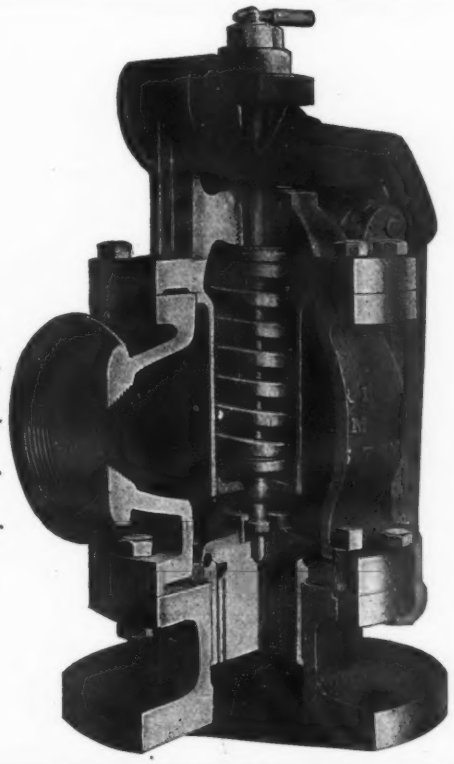
Bids are asked until 3 p.m., Oct. 19, by the water department, Houston, Texas, for the installation of 15,000,000-gallon pumping engine.

The Washtenaw Light and Power Company, Ypsilanti, Mich., has been granted a franchise, and will erect a plant, it is said, at a cost of $60,000.

Plans are being considered for the construction of electric-light plant and ice plant in Byromville, Ga. Seymour Byrom is interested.

The electric-light plant at Fort Gibson, Okla., was destroyed by fire. Loss, about

Simplicity
Quality
Reliability
Safety
Durability



Instant Relief

¶ On account of its great capacity for relief, excessive pressure is instantly relieved when boilers are equipped with

The American "SPECIAL" Pop Safety Valve

¶ No valve so quickly and completely disposes of excess pressure with so little loss.

¶ Special testing nut for testing valve under cold water pressure.

¶ Made of best steam metal to withstand highest temperature and pressures, with all parts extra heavy and durable. Springs are of finest tempered steel. Solid nickel seats.

¶ Send for descriptive circular, fully describing the mechanism of this valve.

American Steam Gauge & Valve Mfg. Co.,

208-220 Camden Street, Boston, Mass.

New York, 26 Cortlandt St. Atlanta, 835 Equitable Bldg. Chicago, 7-9 So. Jefferson St.

Pittsburg, Frick Bldg. Annex
Montreal, 444 St. James Street
San Francisco, 247 Pine Street
Los Angeles, 213 So. Los Angeles St.

When ordering gauges, valves, indicators and kindred appliances for governing, indicating, measuring, recording and controlling steam, air, gas, oil, ammonia and all other pressures, be sure to specify those manufactured by us
Your interests can be best served by the protection they afford

$20,000. Frank Boudinot is president of the company.

The Oakland (Cal.) Gas, Light and Heat Company, will erect a new building to be equipped with turbine engines and an auxiliary plant.

The Rockford (Ill.) Electric Company, it is said, is planning extensive improvements, including the reconstruction of the hydro-electric plant.

It is reported that the Public Service Company, Chickasha, Okla., is contemplating increasing the output of its gas, electric, water and ice plants.

The citizens of Moundsridge, Kan., have voted to issue $11,000 bonds for the construction of an electric-light plant and $17,500 for water works.

The Mt. Ida Hosiery Mills, Marion, N. C., recently incorporated will erect plant. A 25-horsepower engine and 50 horsepower boiler will be installed.

J. Walter Esterline, of Lafayette, Ind., has been appointed to draw plans and specifications for the proposed municipal electric-light plant for Lima, Ohio.

The City Council, Danville, Va., has appropriated $22,000 for improvements to the municipal electric-light plant, to include a new boiler, generator set, etc.

The Naive-Spillers Company, Gallatin, Tenn., has awarded contract for the construction of a packing house. A 20- to 40-ton refrigerating plant will be installed.

The Royalton (Minn.) Power and Light Company will erect an electric-lighting plant on the Platte river. Plans are being prepared by Oscar Claussen, St. Paul, Minn.

Bids will be received until 8 p.m., Oct. 6, by Hon. J. Morris, mayor, for constructing a water-works system at Haddonfield, N. J. George Pfeiffer, Jr., Camden, N. J., is engineer.

Bids will be received until 8 p.m., Oct. 28, by the committee of water supply, Verona, N. J., for constructing water-works system. W. E. Sexton, 46 North Twelfth street, Philadelphia, Penn., engineer.

The Benbow City (Mo.) Light, Power and Heat Company has been granted a franchise to construct and operate an electric-light and power plant and heating plant. The company will spend about $60,000.

The Idaho Railway and Navigation Company, of Spokane, Wash., has been incorporated to build an electric railway. Power house will be on Snake river. Capital stock, $100,000. D. Van Arsdale, president.

Bids will be received until Oct. 10 by the Bureau of Yards and Docks, Navy Department, Washington, D. C., for installing two boilers with stokers, superheaters and stack at the Boston navy yard, as per specification 1600.

The city of Hope, Ark., will open bids Oct. 6 for the construction of water-works system. E. S. Greening, Jr., secretary board of water works, Improvement District No. 1. J. A. Omberg, Jr., Goodwyn building, Memphis, Tenn., engineer.

New Catalogs

C. Lee Cook Manufacturing Company, Louisville, Ky. Booklet. Metallic packings. Illustrated, 36 pages, 3½x6½ inches.

Darley Engineering Company, 80 Broadway, New York. Bulletin No. 1. Suction conveyor. Illustrated, 16 pages, 8x10 inches.

John Erwood, M.E., 1604 West Adams street, Chicago, Ill. Circular. Erwood "positive duplex" blow-off valve. Illustrated.

Harrison Safety Boiler Works, Philadelphia, Penn. Pamphlet. "Steam: Its Profitable Utilization," by Geo. H. Gibson. Illustrated.

Wagner Electric Manufacturing Company, St. Louis, Mo. Bulletin No. 81. Central-Station transformers. Illustrated, 8 pages, 8x10 inches.

The Foos Gas Engine Company, Springfield, Ohio. Circular No. 77. Hoists for mining, contracting and general purposes. Illustrated, 8 pages.

The Under-Feed Stoker Company of America, Marquette building, Chicago, Ill. Pocket catalog. Jones stoker. Illustrated, 18 pages, 4½x9 inches.

Northern Electrical Manufacturing Company, Madison, Wis. Bulletin 55. Type L engine-driven generators. Illustrated, 24 pages, 8x10½ inches. Bulletin 56. Type B belted motors and generators. Illustrated, 4 pages, 8x10½ inches.

Help Wanted

Advertisements under this head are inserted for 25 cents per line. About six words make a line.

AN ENGINEER in each town to sell the best rocking grate for steam boilers. Write Martin Grate Co., 281 Dearborn St., Chicago.

WANTED—Thoroughly competent steam specialty salesman: one that can sell high-grade goods. Address "M. M. Co.," POWER.

WANTED—Representatives in each town to handle an entirely new line of steam specialties. Address "M," Perth Amboy, N. J.

WANTED—Draftsman with fair amount of experience on pumping machinery. Write fully, stating experience and wages expected to start, and giving reference. Box 43, POWER.

NOTICE TO ENGINEERS—If you are desirous of making a change we offer the best opportunity for a nice income to the right man. The best selling specialty for a boiler extant. Selling for $50.00 each. A necessity for every boiler. Liberal contract. Address Power Specialty Co., 236-A Fort St. W., Detroit, Mich.

WANTED—A good live agent in every shop to sell one of the best known preparations for removing grease and grime from the hands without injury to the skin. Absolutely guaranteed. An agent can make from $5 to $25 in addition to his regular salary. This is no fake. Write for free sample and agents' terms. Now is the time to take a good side line to help out. The Klenzola Company, Thirteenth and Peach streets, Erie, Penn.

Situations Wanted

Advertisements under this head are inserted for 25 cents per line. About six words make a line.

WANTED—Position of any kind by a young mechanical engineer; preferably in power house in vicinity of New York. Box 45, POWER.

CHIEF ENGINEER of large industrial plant desires change; active and alive, an expert with indicators and testing apparatus, can keep operating expenses at proper figures. Box 27, POWER.

WITH SEVEN YEARS' experience from shop to electrical engineer in charge of machinery and equipment of a railway light and power system, graduate mechanical engineer desires change. Box 40, POWER.

Miscellaneous

Advertisements under this head are inserted for 25 cents per line. About six words make a line.

WANTED—Early and recent volumes and issues of *Power, Engineer, Steam*, etc. Send lists. A. H. Grant, Elizabeth, N. J.

STIRLING BOILER TUBES, cracking off can stop at once or no pay. Wm. Fulton Engineering Co., office, 28 N. Canal St., Dayton, Ohio.

IS THERE A SHOP that desires to manufacture and control a much sought unit for marine and municipal purposes? Address "Old Super.," POWER.

ALL PRACTICAL ENGINEERS should apply to Wm. O. Webber, Consulting Engineer, 432 Exchange Bldg., Boston, for information concerning tables on all engineering subjects.

PATENTS secured promptly in the United States and foreign countries. Pamphlet of instructions sent free upon request. C. L. Parker, Ex-examiner, U. S. Patent Office, 4 Dietz Bldg., Washington, D. C.

WANTED—High-grade line of power and steam specialties, exclusive agency on commission and guarantee; western Pennsylvania, Ohio, West Virginia; wide experience; large clientage, ample reference. "Results," POWER.

A SUCCESSFUL manufacturers' agency, representing only high-grade power specialties, desires sole selling agency for Greater New York and vicinity; first-class references. H. H. W. Bergmann, 527 East 149th St., New York City.

WANTED—Patented articles which can be used in machine shop, boiler room or engine room. Must have merit. We possess finest facilities for market, having a large force of traveling men in this country and agents in nearly every large city of Europe, who call upon steam users and machine shops. Liberal contract. Highest of references. Address Power Specialty Co., 236-A. Fort St. W., Detroit, Mich.

For Sale

Advertisements under this head are inserted for 25 cents per line. About six words make a line.

FOR SALE—8x12 horizontal slide valve engine, Skinner Engine Co. make. Rose Polytechnic Shops, Terre Haute, Ind.

FOR SALE—Patent right for a reversible-non-reversible rotary engine; steam consumption less than Corliss engines. Box 41, POWER.

150 HORSE-POWER tandem compound Corliss engine, in good order; 16-ft. wheel; 24-in. face. F. W. Iredell, 11 Broadway, New York.

FOR SALE—20x48 Wheelock engine and two 72"x18' high pressure tubular boilers in good condition cheap. Address "Engineer," Box 2, Station A, Cincinnati, Ohio.

FOR SALE—Owing to constructing a new power turbine station, we have for sale one McIntosh & Seymour tandem compound condensing engine with surface condenser and pumps complete 24-46-42", 100 r.p.m. Ready for direct connection to either a.c. or d.c. This engine is in A-1 condition and will be sold at your price. Box 44, POWER.

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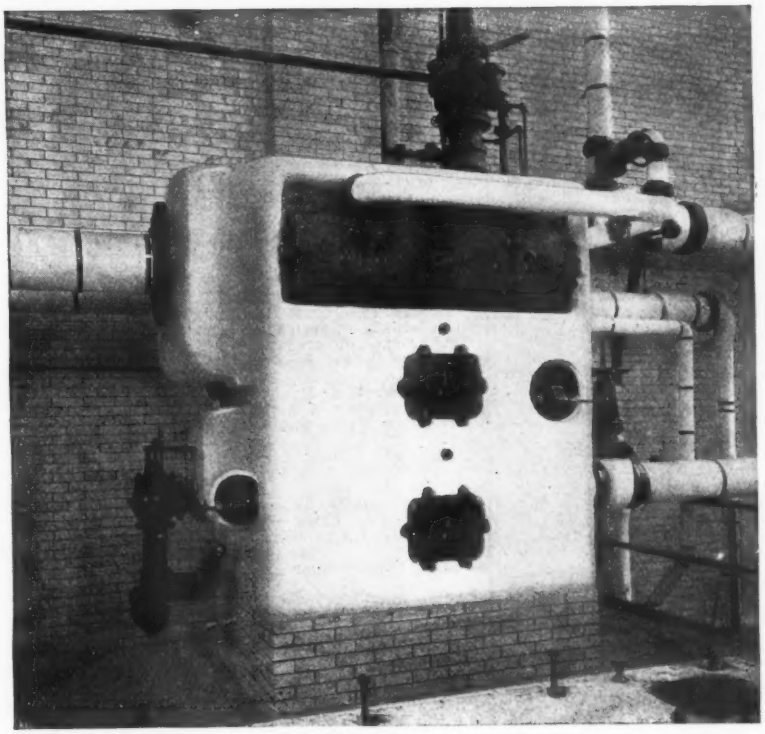

ON REDUCING INSTALLATION COSTS

Apart from what the Cochrane Heater will do and save for you when in service, we believe we can help you on the installation cost.

Hundreds of the Cochrane Heaters sold last year (and this year also) were made up special—or provided with special features such as extra openings—specially located openings, adaptations for low head room, restricted floor space, etc., which enabled the purchaser to save money on piping, valves and connections, arrangement of apparatus and building, etc., over what they would have been compelled to expend had they purchased a standard heater.

Then when you put in any form of closed or pressure heaters you've got to contrive some way of keeping the oil out of them, some way of taking care of the returns, some way of adding the make-up water, etc.

Now, when you put in a Cochrane Heater, you've got all these things provided for, since these Cochranes take the place of closed heater, independent oil separator, return and expansion tanks, steam traps, automatic raw water regulator, feed-water filter and the cost of the valves, piping, fittings and other apparatus necessary for their installation.

Quite often you can save as much as—sometimes more than—one-half the cost of the Cochrane Heater right in the valves and the piping that would be necessary for connecting up any other heater. This may seem strange, but it's so, as we will be glad to demonstrate any time you want to take up an actual case with us.

Talk about getting value! Just think of it—every Cochrane Heater now in service, and there are a good many thousands, figuring up the average, is saving its owner more than twice its cost per year.

What our apparatus does, plus what we do for you, is why we have the choicest business in the world in the Heater and Separator lines.

Try a Cochrane just once!

You Know Some of These Concerns. They All "Use Cochranes".

U. S. Government,
General Electric,
Allis-Chalmers,
Westinghouse,
Baldwin Locomotive,
American Locomotive,
Electric Storage Battery,
Brown & Sharpe,
Carnegie Steel,
National Tube,
Jones & Laughlin,
Pullman Car Company,
American Car & Fdy. Co.,
Eastman Kodak,
American Tobacco,
International Paper,
Pabst Brewing,
Atlas Cement,
Dupont Powder,
Swift & Co.,
U. S. Metallic Cartridge,
Pyle's Pearline,
National Lead,
Standard Oil,
Douglas Shoe,
American Bridge,
Elgin Watch,
Ivory Soap,
Macbeth-Evans,
Barber Asphalt,
Berwind-White,
Aeolean Co.,
Anhauser Busch,
Sherwin-Williams,
Calumet-Hecla,
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Jno. Wanamaker,
Marshall Field,
Cheney Bros.,
Clark Thread,
Winchester Arms,
Tiffany & Co.,
International Harvester Co.;
Lehigh Valley Coal,
Penna. R. R.
N. Y. Central,
L. S. & M. S.
Illinois Central,
C. M. & S. P.,
Canadian Pacific,
N. Y. Subway,
Uneeda Biscuit.

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17th and Clearfield Sts., PHILADELPHIA, PA.

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Wisconsin Engine Co., Corliss, Wis.
York Mfg. Co., York, Pa.

Air Cooling Apparatus

De La Vergne Machine Co., New York.
Triumph Ice Machine Co., Cincinnati, Ohio.

Alarms, High and Low Water

Pittsburgh Gage and Supply Co., Pittsburgh, Pa.
Reliance Gauge Column Co., Cleveland, O.

Arch, Back Combustion Chamber

McLeod & Henry Co., Troy, N. Y.
Mayville Specialty Mfg. Co, Mayville, Wis.

Arch, Boiler

McLeod & Henry Co., Troy, N. Y

Arch, Boiler Door

Mayville Specialty Mfg. Co., Mayville, Wis
McLeod & Henry Co., Troy, N. Y.
Presbrey Fire Brick Co., Taunton, Mass.

Asbestos Goods

Carey Co., The Philip, Cincinnati, O
Johns-Manville Co., H. W., New York.
Restein Co., Clement, Philadelphia, Pa.

Bars, Cylinder Boring

Underwood & Co., H. B., Phila., Pa.

Bars, Grate

Reagan Grate Bar Co., Philadelphia, Pa.

Batteries, Storage

Westinghouse Machine Co., Pittsburg, Pa.

Belt Dressing

Cling-Surface Co., Buffalo, N. Y.
Dixon Crucible Co., Jos., Jersey City, N. J.
Garlock Packing Co., Palmyra, N. Y.
Johnson Co., Henry, Jersey City, N.J.
Rhoads & Son, J. E., Phila., Pa.
Shultz Belting Co., St. Louis, Mo.
Stephenson Mfg. Co., Albany, N. Y.
Walton Co., F. S., Philadelphia, Pa.

Belt Fasteners

Bristol Company, The, Waterbury, Conn.

Belt Lacing

Bristol Co., The, Waterbury, Conn.

Belting

Anchor Packing Co., Philadelphia, Pa.
Diamond Rubber Co., Akron, Ohio.
Garlock Packing Co., Palmyra, N. Y.
N. Y. Belting & Packing Co., New York.
Peerless Rubber Mfg. Co., New York.
Quaker City Rubber Co., Philadelphia, Pa.
Restein Co., Clement, Philadelphia, Pa.
Rhoads & Sons, J. E., Phila., Pa.
Robins New Conveyor Co., New York.
Shultz Belting Co., St. Louis, Mo.

Benders, Hydraulic

Watson-Stillman Co., New York.

Bends, Wrought Iron Pipe

Harrisburg Pipe and Pipe Bending Co., Harrisburg, Pa.
Pittsburgh Gage and Supply Co., Pittsburgh, Pa.
Whitlock Coil Pipe Co., Hartford, Conn.

Blocks, Chain

Yale & Towne Mfg. Co., New York.

Blowers

Beggs & Co., James, New York
De Laval Steam Turbine Co., Trenton, N. J.
Green Fuel Economizer Co., Matteawan, N. Y.
McClave-Brooks Co., Scranton, Pa.
Ohio Blower Co., Cleveland, O.
Sirocco Engineering Co., New York.
Sturtevant Co., B. F., Hyde Park, Mass
Wing Mfg. Co, L. J., New York.

Blowers, Furnace

McClave-Brooks Co., Scranton, Pa.

Boiler Feeders

American Boiler Economy Co., Philadelphia, Pa.
Davis Regulator Co., G. M., Chicago, Ill.
Dean Bros. Steam Pump Works, Indianapolis, Ind.
Lunkenheimer Co., Cincinnati, O
Myers & Bro., F. E., Ashland, O.
Pittsburgh Gage & Supply Co., Pittsburg, Pa.

Boiler Skimmers

Buckeye Boiler Skimmer Co., Toledo, Ohio.

Boilers, Second Hand

Wickes Boiler Co., Saginaw, Mich.

Boilers, Tubular

Babcock & Wilcox Co., New York.
Beggs & Co., James, New York.
Edge Moor Iron Co., Edge Moor, Del.
Franklin Boiler Works Co., Troy, N. Y.

Boilers, Tubular—*Continued.*

Griffith & Wedge Co., Zanesville, O.
Heine Safety Boiler Co., St. Louis, Mo.
Keeler & Co., E., Williamsport, Pa.
Kewanee Boiler Co., Kewanee, Ill.
Oil Well Supply Co., Oswego, N. Y.
Robb-Mumford Boiler Co., Amherst, N. S.
Struthers-Wells Co., Warren, Pa.
Vilter Mfg. Co., Milwaukee, Wis.
Wetherill & Co., Robert, Chester, Pa.
Wickes Boiler Co., Saginaw, Mich.

Boilers, Water Tube

Babcock & Wilcox Co., New York.
Edge Moor Iron Co., Edge Moor, Del.
Franklin Boiler Works, Troy, N. Y.
Heine Safety Boiler Co., St. Louis, Mo.
Keeler Co., E., Williamsport, Pa.
Kewanee Boiler Co., Kewanee, Ill.
Morrin Climax Boiler Co., Brooklyn, N. Y.
Oil Well Supply Co., Oswego, N. Y.
Parker Boiler Co., Philadelphia, Pa.
Rust Boiler Co., Pittsburg, Pa.
Struthers-Wells Co., Warren, Pa.
Vogt Machinery Co., Henry, Louisville, Ky.
Wetherill & Co., Robt., Chester, Pa.
Wickes Boiler Co., Saginaw, Mich.

Books

American School of Correspondence, Chicago, Ill.
Hill Publishing Co., New York.
International Text Book Co., Scranton, Pa.
System Co., Chicago, Ill.

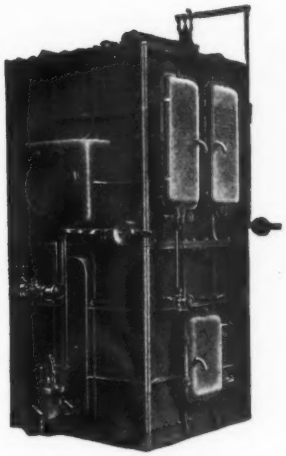
Boosters

Ridgway Dynamo & Engine Co., Ridgway, Pa.

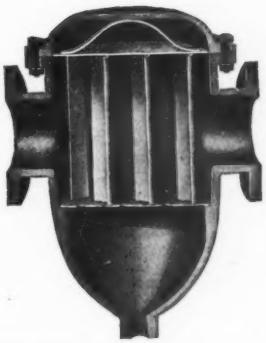
Building Materials, Fireproof

Carey Co., The Philip, Cincinnati, O.
Johns-Manville Co., H. W., New York.

There's Real Money In Exhaust Steam.

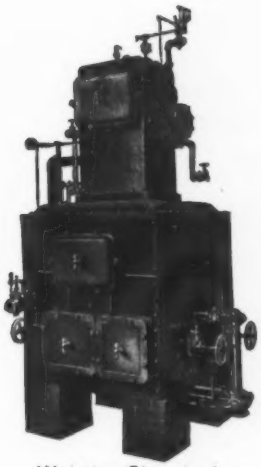


Webster Feed Water Heater, Purifier and Filter



Webster Standard Horizontal Oil Separator

You Can Get It By Using



Webster Chemical Purifier

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To make the exhaust steam help the coal pile do its work—that is the prime function of Webster Appliances. In the exhaust lies the largest liability to loss, or the greatest possibility to save—according to its utilization.

Webster Steam Specialties have proved their ability to extract highest economy from exhaust steam, in thousands of plants.

The engineer's question is no longer "Is my exhaust steam valuable?" but, "How can I make it MOST valuable?." And Webster Specialties are designed to answer this latter question. That they answer it more satisfactorily than any other known devices is what we want to prove to YOU—and in that proof you'll see your way to the highest possible steam economy.

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CAMDEN, NEW JERSEY

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Castings, Brass and Iron

Homestead Valve Mfg. Co., Pittsburg, Pa.
McClave-Brooks Co., Scranton, Pa.
Ohio Brass Co., Mansfield, O.
Pittsburgh Gage and Supply Co., Pittsburgh, Pa.

Castings, General

Neemes Bros., Troy, N. Y.

Castings, Malleable

Jeffrey Mfg. Co., Columbus, O.

Cement, Asbestos

Johns-Manville Co., H. W., New York.
N. Y. Belting & Packing Co., New York.

Cement, Boiler

Smooth-On Mfg. Co., Jersey City, N. J.

Chimneys

Wiederholdt Construction Co., Chicago, Ill.

Chimneys, Reinforced Concrete

Wiederholdt Construction Co., Chicago, Ill.

Clamps, Steam Joint

McCrea & Co., James, Chicago, Ill.

Cleaners, Boiler Tube

Buckeye Boiler Skimmer Co., Toledo, Ohio.
Garlock Packing Co., Palmyra, N. Y.
General Specialty Co., Buffalo, N. Y.
Liberty Mfg. Co., Pittsburg, Pa.
Monarch Steam Blower Co., Troy, N. Y.
Pierce Co., Wm. B., Buffalo, N. Y.
Stewart Heater Co., Buffalo, N. Y.

Clocks

American Steam Gauge and Valve Mfg. Co., Boston, Mass.

Clutches, Friction

Williams Fdry. & Mach. Co , Akron, Ohio.

Cocks, Blow-Off

Liberty Mfg. Co., Pittsburg, Pa.
Lunkenheimer Co., Cincinnati, O.
Pittsburgh Gage and Supply Co., Pittsburgh, Pa.

Cocks, Gage

American Steam Gauge & Valve Mfg. Co., Boston, Mass.
Huyette Co., P. B., Philadelphia, Pa.
Ohio Brass Co., Mansfield, Ohio.
Pittsburgh Gage and Supply Co., Pittsburgh, Pa.
Reliance Gauge Column Co., Cleveland, O.
Williams Valve Co., D. T., Cincinnati, Ohio.

Cocks, Steam

Homestead Valve Mfg. Co., Pittsburg, Pa.
Williams Valve Co., D. T., Cincinnati, O.

Compound, Boiler

Binghamton Boiler Compound Co., Binghamton, N. Y.
Bird-Archer Co., New York.
Buckeye Boiler Skimmer Co., Toledo, Ohio.
Dearborn Drug & Chemical Co., Chicago, Ill.
Hawk-Eye Compound Co., Chicago, Ill.
Johns-Manville Co., H. W., New York.

Compound, Lubricating

Cook's Sons, Adam, New York.

Condensers

Alberger Condenser Co., New York
Baragwanath & Son, Wm., Chicago, Ill.
Minneapolis Steel & Mach'y Co., Minneapolis, Minn.
Schutte & Koerting Co., Philadelphia, Pa.
Stewart Heater Co., Buffalo, N. Y.
Southwark Foundry and Machine Co., Philadelphia, Pa.
Wheeler Condenser and Engineering Co., New York.

Consumers, Smoke

Climax Smoke Preventer Co., Boston, Mass.

Controllers, Electric

General Electric Co., Schenectady, N. Y.
Westinghouse Electric and Mfg. Co., Pittsburg, Pa

Controllers, Feed Water

American Boiler Economy Co., Philadelphia, Pa.

Cooling Towers

Alberger Condenser Co., New York.
Baragwanath & Sons, Wm., Chicago, Ill.
Wheeler Condenser and Engineering Co., New York.

Correspondence Schools

American School of Correspondence, Chicago, Ill.
International Correspondence Schools, Scranton, Pa,

Couplings, Clutch

Williams Fdry. & Mach. Co., Akron, Ohio

Covering, Pipe and Boiler

Carey Co., The Philip, Cincinnati, O.
Johns-Manville Co., H. W., New York.
U. S. Mineral Wool Co., New York.
Wyckoff & Son Co., A., Elmira, N. Y.

Crabs

Yale & Towne Mfg. Co., New York.

Cranes

Yale & Towne Mfg. Co., New York.

Die Stocks

Bignall & Keeler Mfg. Co., Edwardsville, Ill.
Curtis & Curtis Co., Bridgeport, Conn.
Loew Mfg. Co., Cleveland, O.
Oster Mfg. Co., Cleveland, O.

District Steam Heating

American District Steam Co., Lockport, N. Y.

Draft Apparatus, Mechanical

Green Fuel Economizer Co., Matteawan, N. Y.
Wing Mfg. Co., L. J., New York.

Dressing, Rope

Cling-Surface Co., Buffalo, N. Y.

Drills, Upright

Barnes Co., W. F. & John, Rockford, Ill.

Dynamos and Motors, Alternating Current

Clark Bros. Co., Belmont, N. Y.
Crocker-Wheeler Co., Ampere, N. J.
Fort Wayne Electric Works, Ft. Wayne, Ind.
General Electric Co., Schenectady, N. Y.
Northern Electrical Mfg. Co., Madison, Wis.
Ridgway Dynamo & Engine Co., Ridgway, Pa.
Westinghouse Electric and Mfg. Co., Pittsburg, Pa.

Dynamos and Motors, Direct Current

Crocker-Wheeler Co., Ampere, N. J.
Fort Wayne Electric Works, Ft. Wayne, Ind.
General Electric Co., Schenectady, N. Y.
Northern Electrical Mfg. Co., Madison, Wis.
Ridgway Dynamo & Engine Co., Ridgway, Pa.
Triumph Electric Co., Cincinnati, O.
Westinghouse Electric and Mfg. Co., Pittsburg, Pa.

Economizers, Fuel

Green Fuel Economizer Co., Matteawan, N. Y.

Educational

American School of Correspondence, Chicago, Ill.
International Correspondence Schools, Scranton, Pa.

Ejectors

Beggs & Co., James, New York.
Lunkenheimer Co., Cincinnati, O.
Ohio Injector Co., Wadsworth, O.
Penberthy Injector Co., Detroit, Mich.

Electrical Engineers

Crocker Wheeler Co., Ampere, N. J.
Northern Electrical Mfg. Co., Madison, Wis.

Engines, Blowing

Wisconsin Engine Co., Corliss, Wis.

Engines, Corliss

Bates Machine Co., Joliet, Ill.
Beggs & Co., James, New York.
Cooper Co., C. & G., Mt. Vernon, O.
Griffith & Wedge Co., Zanesville, O.
Minneapolis Steel & Mach'y Co., Minneapolis, Minn.
Providence Eng. Works, Providence, R. I.
Southwark Foundry and Machine Co., Philadelphia, Pa.
Vilter Mfg. Co., Milwaukee, Wis.
Watertown Engine Co., Watertown, N. Y.
Wetherill & Co., Robert, Chester, Pa.
Wheeler Condenser & Engineering Co., New York.
Wisconsin Engine Co., Corliss, Wis.

Engines, Gas and Gasolene

Alberger Co., A. H., Buffalo, N. Y.
Buckeye Engine Co., Salem, Ohio.
De La Vergne Machine Co., New York.
Du Bois Iron Works, Du Bois, Pa.
Foos Gas Engine Co., Springfield, O.
Minneapolis Steel & Mach'y Co., Minneapolis, Minn.
Riverside Engine Co., Oil City, Pa.
Struthers-Wells Co., Warren, Pa.
Westinghouse Machine Co., Pittsburg, Pa.
Wisconsin Engine Co., Corliss, Wis.

Engines, High Speed

American Engine Co., Bound Brook, N. J.
Ball Engine Co., Erie, Pa.
Bates Machine Co., Joliet, Ill.
Buckeye Engine Co., Salem, Ohio.
Clark Bros. Co., Belmont, N. Y.
Erie Mfg. & Supply Co., Erie, Pa.
Fitchburg Steam Eng. Co., Fitchburg, Mass.
Minneapolis Steel & Mach'y Co., Minneapolis, Minn.
Shepherd Engineering Co., Williamsport, Pa.
Skinner Engine Co., Erie, Pa.
Southwark Foundry & Machine Co., Philadelphia, Pa.
Watertown Engine Co., Watertown, N. Y.
Westinghouse Machine Co., Pittsburg, Pa.

Engines, Hoisting

Wisconsin Engine Co., Corliss, Wis.

Engines, Medium and Low Speed

Ball Engine Co., Erie, Pa.
Brown Engine Co., C. H., Fitchburg, Mass.
Buckeye Engine Co., Salem, Ohio.
Erie Mfg. & Supply Co., Erie, Pa.
Fitchburg Steam Engine Co., Fitchburg, Mass.
Minneapolis Steel & Mach'y Co., Minneapolis, Minn.
Shepherd Engineering Co., Williamsport, Pa.
Skinner Engine Co., Erie, Pa.
Southwark Foundry & Mach. Co., Philadelphia, Pa.
Westinghouse Machine Co., Pittsburg, Pa.

Engines, Oil

De La Vergne Machine Co., New York.

Engines, Rolling Mill

Wisconsin Engine Co., Corliss, Wis.

Engines, Rotary

Ball-Cooley Engineering Co., New York.

Engines, Steam

Ridgway Dynamo & Engire Co., Ridgway, Pa.

Exhaust Heads

Burt Mfg. Co., Akron, O.
Gardner Gov. & Separator Co., Quincy, Ill.
Hoppes Mfg. Co., Springfield, O.
Ohio Blower Co., Cleveland, O.
Pittsburgh Gage and Supply Co., Pittsburgh, Pa.
Sims Co., Erie, Pa.
Whitlock Coil Pipe Co., Hartford, Conn.

Fans, Electric

Fort Wayne Electric Works, Ft. Wayne, Ind.
General Electric Co., Schenectady, N. Y.
Triumph Electric Co., Cincinnati, O.
Westinghouse Elec. and Mfg. Co., Pittsburg, Pa.

Fans, Exhaust and Ventilating

Ohio Blower Co., Cleveland, O.
Sirocco Engineering Co., New York.

Fans, Mine Ventilating

Jeffrey Mfg. Co., Columbus, O.

Feed Water Heaters and Purifiers

Alberger Condenser Co., New York.
Baragwanath & Son, Wm., Chicago, Ill.
Bates Machine Co., Joliet, Ill.
Eclipse Feed Water Heater and Purifier Co., Appleton, Wis.
Erie Mfg. & Supply Co., Erie, Pa.
Goubert Mfg. Co., New York.
Griscom-Spencer Co., New York
Harrison Safety Boiler Wks., Philadelphia, Pa.
Harrisburg Pipe and Pipe Bending Co., Harrisburg, Pa.
Hoppes Mfg. Co., Springfield, O.
Kewanee Boiler Co., Kewanee, Ill.
Loew Mfg. Co., Cleveland, O.
National Pipe Bending Co., New Haven, Conn.
Patterson & Co., F. L., New York.
Sims Co., Erie, Pa.
Stewart Heater Co., Buffalo, N. Y.
Webster & Co., Warren, Camden, N. J.
Wheeler Condenser and Engineering Co., New York.
Whitlock Coil Pipe Co., Hartford, Conn.
Wickes Boiler Co., Saginaw, Mich

Filters, Feed Water

Beggs & Co., James, New York.
Eclipse Feed Water Heater and Purifier Co., Appleton, Wis.
Keystone Chemical Co., Philadelphia, Pa.

Filters, Oil

Burt Mfg. Co., Akron, O.
Liberty Mfg. Co., Pittsburg, Pa.
Pittsburgh Gage & Supply Co., Pittsburg, Pa.
Sims Co., Erie, Pa.

Fire Brick

C-O-Two Furnace Co., Syracuse, N. Y.
McLeod & Henry Co., Troy, N. Y.
Presbrey Fire Brick Co., Taunton, Mass.

Fittings, Ammonia

American Steam Gauge and Valve Mfg. Co., Boston, Mass.
De La Vergne Machine Co., New York.
Triumph Ice Machine Co., Cincinnati, O.
York Mfg. Co., York, Pa.

Fittings, Boiler

American Steam Gauge and Valve Mfg. Co., Boston, Mass.
Lunkenheimer Co., Cincinnati, O.
Pittsburgh Gage and Supply Co., Pittsburgh, Pa.

Fittings, Flange, High or Low Pressure

Lunkenheimer Co., Cincinnati, O.
Pittsburgh Gage & Supply Co., Pittsburg, Pa.
Pittsburgh Valve & Fittings Co., Barberton, O.
Pittsburgh Valve, Foundry & Construction Co., Pittsburg, Pa.
Williams Valve Co., D. T., Cincinnati, Ohio.

Fittings, Hydraulic

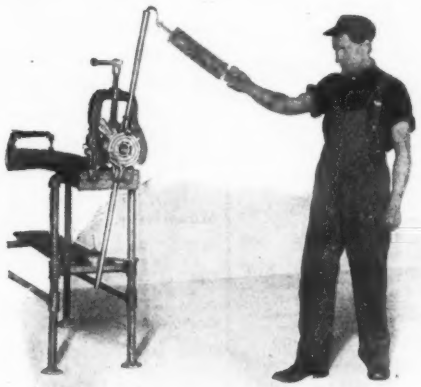
Watson-Stillman Co., New York.

Fittings, Pipe

Triumph Ice Machine Co., Cincinnati, Ohio.
Ohio Brass Co., Mansfield, O.

Flanges

Central Station Steam Co., Detroit, Mich.



The Scale Registers 12 Pounds

at start of thread—45 pounds at the finish—on 2" galvanized pipe.
One Set of Dies. *No Bushings.*

The Oster Mfg. Company,
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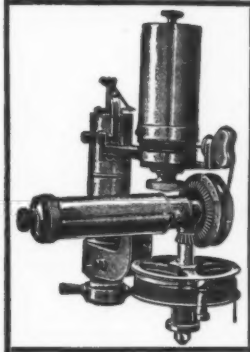

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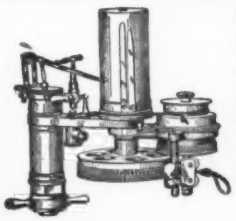

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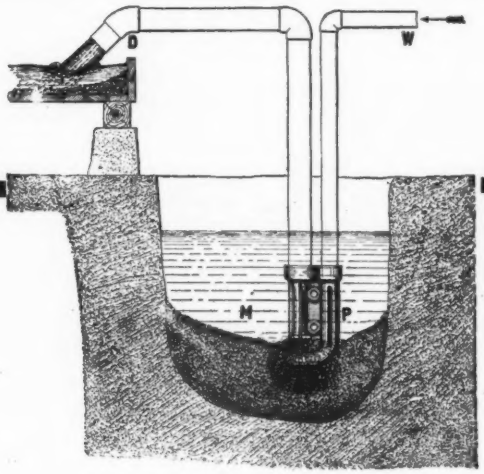

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Greene, Tweed & Co., New York.
Mercer Rubber Co., Hamilton Square, N. J.
National India Rubber Co., Bristol, R. I.
New York Belting & Packing Co., New York.
Peerless Rubber Mfg. Co., New York.
Quaker City Rubber Co., Phila., Pa.
Restein Co., Clement, Phila., Pa.

Schools, Correspondence
American School of Correspondence, Chicago, Ill.
International Correspondence Schools, Scranton, Pa.

Separators and Extractors, Steam and Oil
Baragwanath & Son, Wm., Chicago, Ill.
Beggs & Co., Jas., New York.
d'Este Co., Julian, Boston, Mass.
Direct Separator Co., Syracuse, N. Y.
Goubert Mfg. Co., New York.
Harrison Safety Boiler Works, Philadelphia, Pa.
Hoppes Mfg. Co., Springfield, O.
Liberty Mfg. Co., Pittsburg, Pa.
Ohio Blower Co., Cleveland, O.
Patterson & Co., F. L., New York.
Pittsburgh Gage & Supply Co., Pittsburgh, Pa.
Robertson & Sons, Jas. L., New York.
Sims Co., Erie, Pa.
Watson & McDaniel Co., New York.
Webster & Co., Warren, Camden, N. J.
Wheeler Condenser & Engineering Co., New York.
Whitlock Coil Pipe Co., Hartford, Conn.
Williams Valve Co., D. T., Cincinnati, O.

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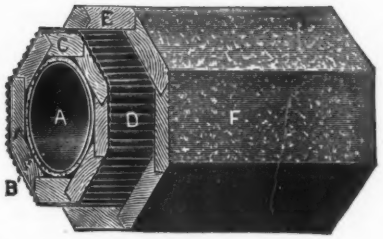
Wyckoff's Patent Coverings



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For steam and hot water Pipes Wyckoff's Coverings are unsurpassed. Made of a combination of non-conductive materials—selected, well-seasoned white pine principally. They are light and durable beyond all others. Their construction prevents burning or charring and is proof against the radiation of heat. Apply them to your pipes and you have a big economizer in steam and a dividend payer as permanent as your plant itself.

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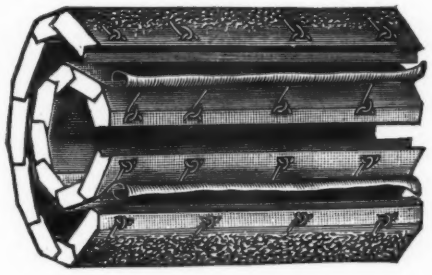

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Established 1855.

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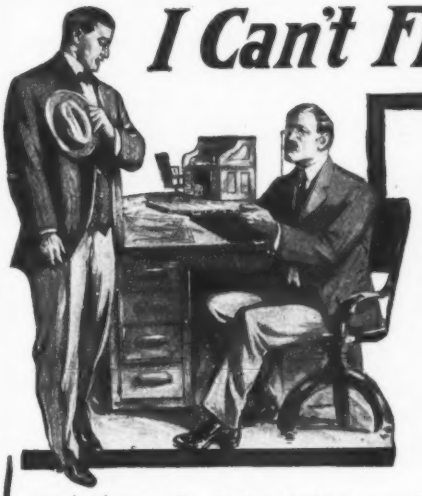

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Berry Engineering Co., Chester, Pa.
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Harrison Safety Boiler Works, Philadelphia, Pa.
Hoppes Mfg. Co., Springfield, O.
Liberty Mfg. Co., Pittsburg, Pa.
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Lunkenheimer Co., Cincinnati, Ohio.
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Schutte & Koerting Co., Philadelphia, Pa.
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York Mfg. Co., York, Pa.

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Crosby Steam Gage & Valve Co., Boston, Mass.
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Lunkenheimer Co., Cincinnati, O.

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Lunkenheimer Co., Cincinnati, O.
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Valves, Exhaust Relief

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Valves, Float

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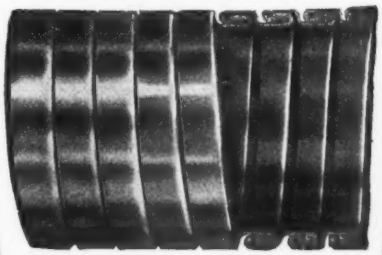

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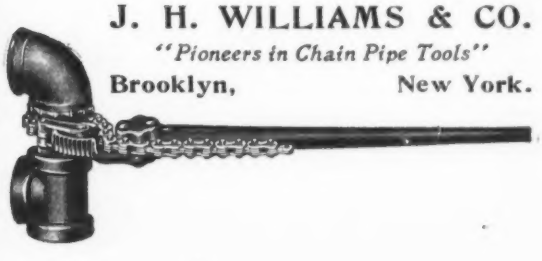

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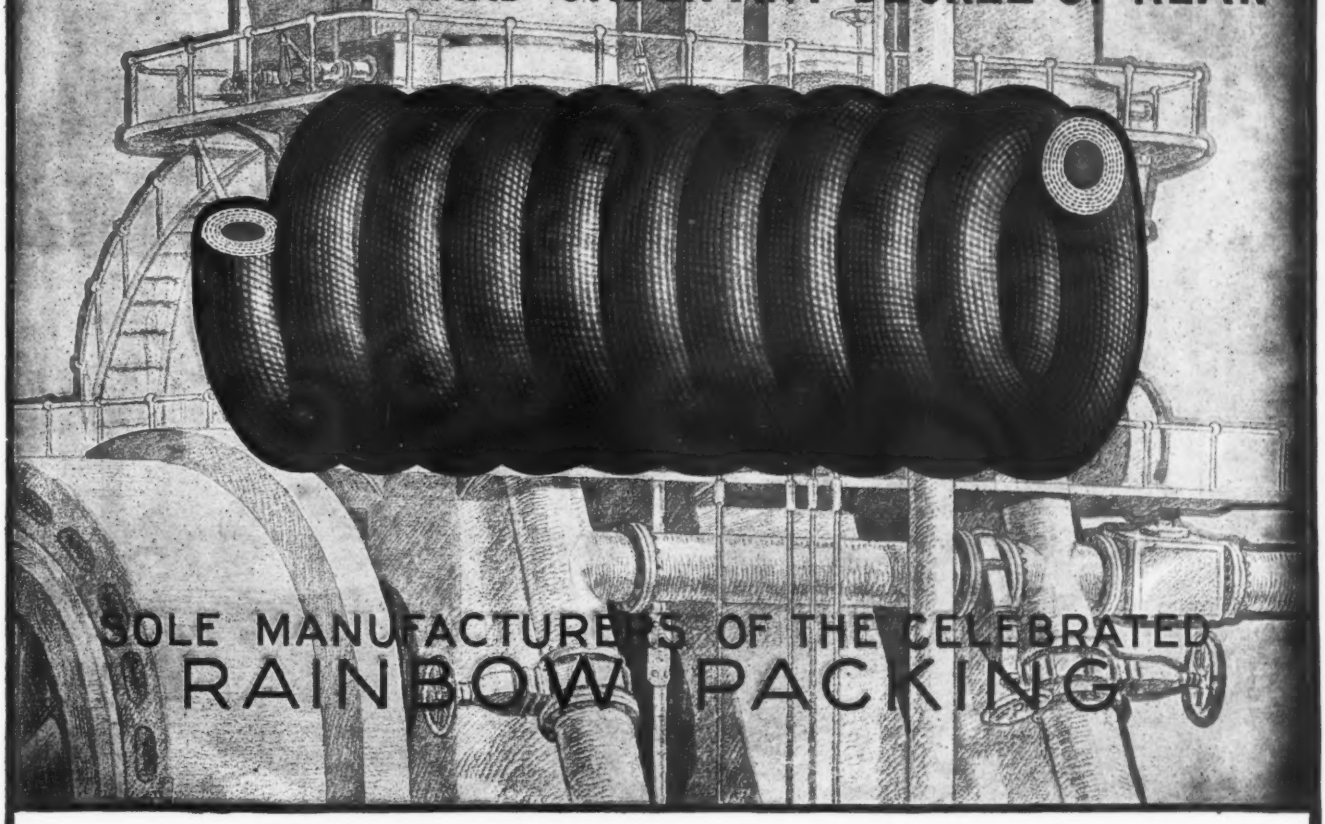

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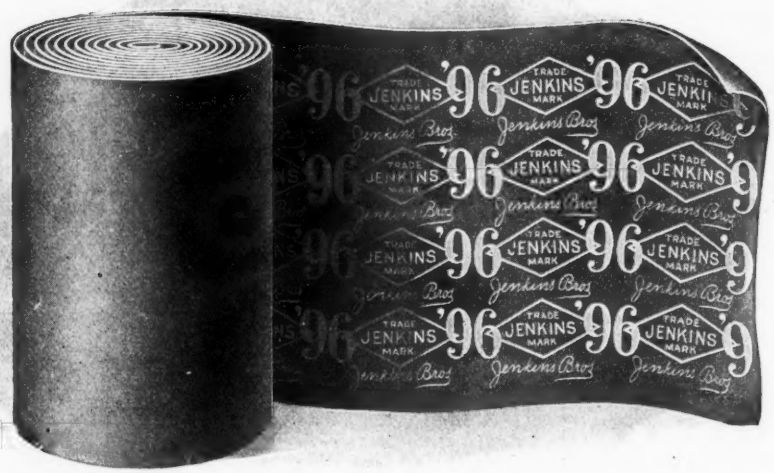

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It does not dry out or become hard and brittle, but retains its tough elastic qualities, either in or out of service. Ammonia, Liquor, Alkali, Oils or Acids have little or no effect on it, and joints can be broken numerous times without renewing the packing.

Indestructible White Sheet Packing is also made with wire insertion.

We manufacture a complete line of high class rubber goods, comprising Belting, Air, Fire, Garden, Steam, Suction, Pneumatic Tool and Water Hose Packings, Gaskets, Mats, Matting, Stopples, Special Mould Goods, Interlocking Rubber Tiling, Tubing, etc.

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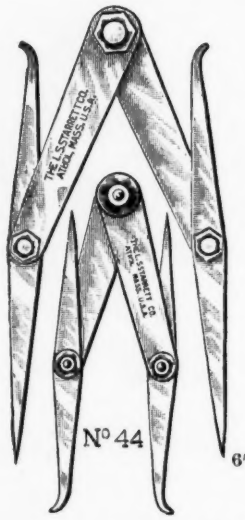

6" size.

For inside and outside work.

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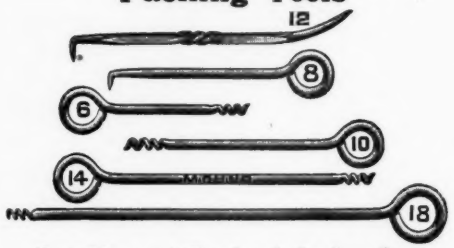
Double Calipers

These are a convenient combination instrument arranged to be used as either inside or outside calipers, and with points to be used as compasses. The joints are an improved form with firm friction grip which holds the calipers in any position to which they are adjusted and prevents looseness and side play.

Packing Tools



Repacking a stuffing box is hard work unless you have the right tools. These will enable you to do the work in half the time that you can without them. Nickel-plated.

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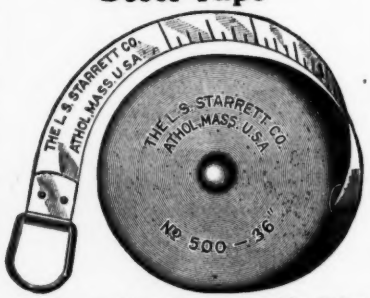
Scraping Tools

A necessity in every engine room. This set includes six of varying shapes and sizes, made of best tool steel forged and tempered. Furnished in oak case which keeps them in good order.

Steel Tape



It is a quarter of an inch wide, 6 feet long, locks at any point and returns to case by spring. Mounted in well finished nickel case.

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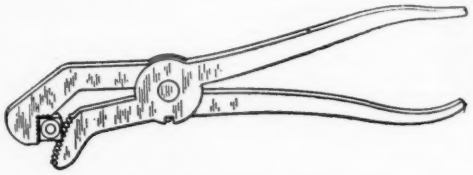

Lightning Wrench

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This tool combines a pipe wrench, which holds any size pipe, a nut wrench for either square or hexagon nuts, wire cutter, screw driver and tack puller. No adjustments are needed and it is always ready for use. It will go into corners where other tools cannot be worked. Nickel-plated, strong and durable.

A Pocket Level

This level is made with strong, heavily nickel-plated case, 3.5 inches long. Hexagonal in shape, and it can be used in inaccessible places to determine the adjustment of crosshead guides and of bearings.

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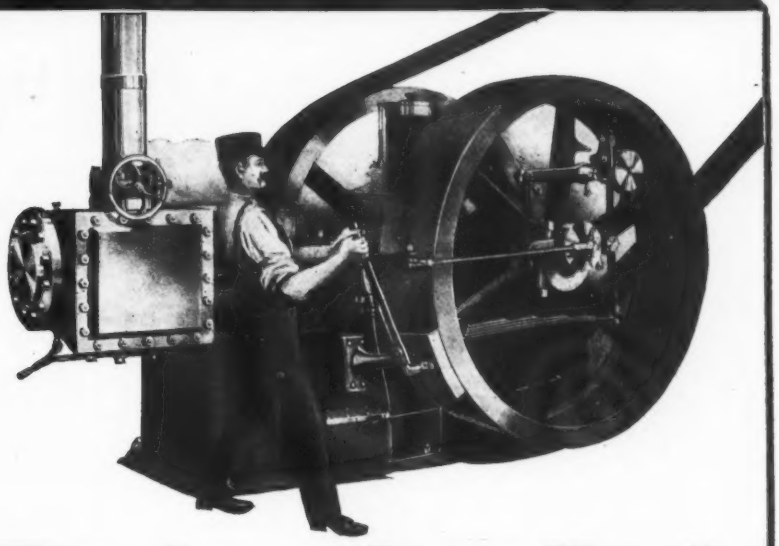
Stop Running Your Engine With A Brake Applied



You wouldn't think of trying to run your engine with a brake set tightly on the fly-wheel. Yet that is literally what you are doing when you operate it with rubber or other frictional material packed tightly around the moving parts.

Hold a piece of rubber around a shafting and see what a resistance (friction) there is when you pull the shafting through the rubber. Then think of the friction on the moving parts of your engine, with rubber or other old-style packings pressing tightly around them.

Think what a large amount of power and coal is thus wasted, and what unnecessary wear and tear there is on the rods, engine and packing.

J-M Asbestos Packings

ARE ABSOLUTELY FRICTIONLESS

Their smooth, silky *asbestos* fibres do not offer the slightest resistance to the moving parts. No power wasted. No rods cut.

But this is only one of the superior features of J-M ASBESTOS PACKINGS. They have all the good features of other packings with the bad features left out.

Don't let any old-fogy idea keep you from trying J-M ASBESTOS PACKINGS any longer. A little thought will tell you that *Asbestos* is the only material from which modern packings can be made.

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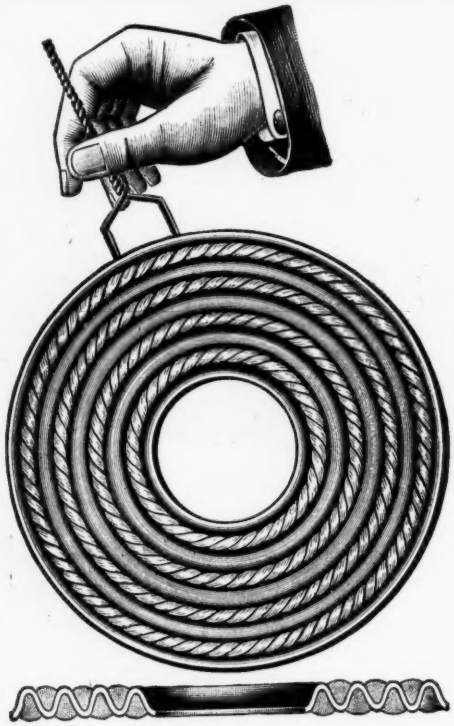

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were introduced. Pick out the worst joint in your plant—send us the size and we will furnish a Goetze gasket which will end the trouble.

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Will tell you it has the
STAYING AND RESISTING QUALITIES

It is efficient in every respect which, in the end, means economy.

A 14 x 28 hanger, like cut herewith, but in colors, free to any engineer upon request.

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The Wise Packing Seeker Will Stop At "Eureka"

When he comes to pay for it, he'll find it *costs a third less* than any other high-grade packing.

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"Eureka" saves time, money and trouble. It makes friends quickly—and *keeps them.* If you've never tried it; now's the time!

This Label

is placed on every box of Genuine "Eureka" for your protection. Don't be talked into accepting some substitute. All substitutes lack "Eureka" quality. We also make Cut Ring, High Pressure, Water Proof Hydraulic Spiral and Red Sheet Packings. Samples and prices on request.

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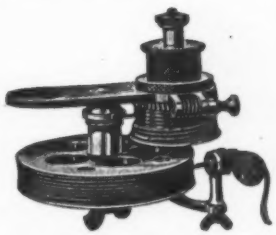

and Victor Reducing Wheel should be relied upon by every engineer who is looking for advancement. It is cheap in initial cost and sold on easy terms. Remember; the *Willis Planimeter* has no equal. Particulars?

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PLASTIC METALLIC PACKING

For Steam, Water, Air, Gas, Hydraulic Machines, Valves, Etc.

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will not blow out—Are **Tough, Pliable** and can be used over several times.

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for Condenser, Feed and other services will last longer and save money and trouble. Will stand oil and hot water.

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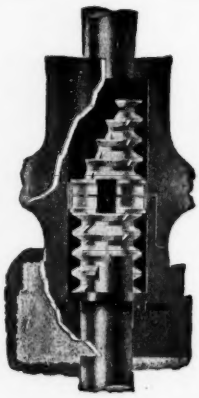

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AMMONIA PACKING

is the **perfect packing** for ammonia rods. It adapts itself to expansion and contraction, and if put on correctly, will **positively hold.**

Good also for steam, gas or air. Write for catalog.

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GOODS MADE IN SHEETS ONLY OF 4½' x 4½' AND 4½' x 9', IN ALL THICKNESSES

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BELMONT "1903" EXPANSION PACKING, Style No. 1, with three break joints, which, when joined, makes practically a solid ring. For shallow stuffing boxes this packing cannot be equaled, as a single ring will prevent escape of steam. Especially suitable for **ammonia** and **steam** up to 125 lbs. pressure. Write for booklet A.

BELMONT HIGH PRESSURE WEDGE PACKING, Style No. 50, composed of two asbestos sliding wedges from which all metallic particles have been removed by the magnetic process, and a back containing a ruober compound which is absolutely unaffected by highest steam pressures. Lubricated by best special high test lubricating compound, in connection with best graphite. The only safe packing for **high pressure** or **superheated steam.** Write for booklet B.

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Sample Ring of either of these three packings free. Fill in coupon with name of kind wanted.

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Gentlemen:—Send me a sample ring of.....
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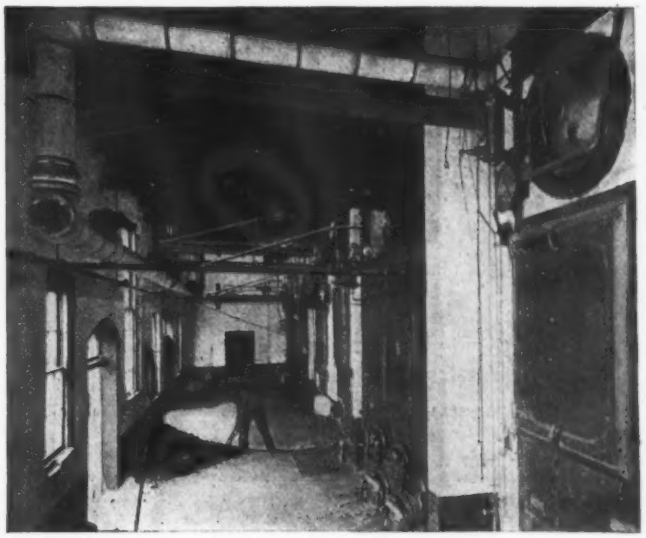
To call at power plants, pumping stations and engine rooms, and sell BELMONT PACKINGS and Specialties. Particularly attractive proposition for manufacturers, agents and engineers in territory not already covered. CLEMENT RESTEIN CO., 133 North Second Street, Philadelphia, Pa.



"Never mind, don't worry, sir, the Queen has lots of sailors!"

said a Dutch Admiral to the British Admiral whose broadside salute had accidentally decapitated one of the Dutch sailors.

The U. S. Navy Department takes no such fatalistic view, but exercises every precaution to see that its plants are well designed and operated and perfectly protected. Recently SIX

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were purchased for the U. S. Naval Torpedo Station, at Newport, R. I. These Regulators effectively protect the boiler by preventing low water and the engine by preventing high water. Moreover, they increase the effectiveness of fuel economizers and feed water heaters enough to repay their cost in a short time. They are easily installed and we guarantee them for five years. We can refer to plants where they have been in successful use for 10 years.

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Johnson's Packings once ordered are always reordered.
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ONE QUARTER TURN opens or closes the **HOMESTEAD**, the valve with the wonderful wear-proof features. Write.

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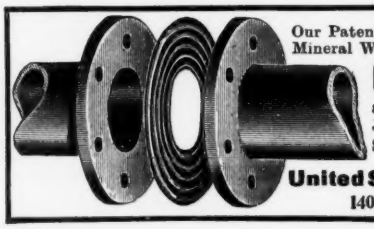

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EVERY POUND OF STEAM MEANS SO MUCH COAL.

The Mason Reducing Valve

will keep the steam pressure just where you want it and save astonishing quantities of coal.

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Here's a jolly engineer parading with the boys
She's out to have a lot of fun, and doesn't mind the noise,
But like the rest she knows what's best, and bears aloft a banner
That says: *Black Squadron can't be beat* in any shape or manner.

BLACK SQUADRON

This packing with four wedges, one of them a lubricated flax and rubber cushion, is the *latest* and *best* achievement in packing design and manufacture.

It is made on the same principle as a universal chuck, and has the same wonderful ability to meet every possible irregularity of the rod or stuffing box. It gives greatest rod pressure with minimum friction and minimum gland pressure. It permits fifty per cent. of draw, thereby enabling BLACK SQUADRON to outlast ordinary packings several times over. Other advantages too numerous to mention here. Write for free catalog.

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Is It Policy to Sacrifice The Harmony Of Your Entire Plant Through Careless Installation of Valves?

With wide-awake, progressive business men, **positively no!**

With such men no pipage equipment but the best will pass —**absolutely none but the best at the start!**

A plant equipped right at the start will remain right! A plant equipped right at the start will create safety and satisfaction to all concerned!

Every valve and every piece of pipage equipment made by us is not only right at the start, but IT'S RIGHT FOR ALL TIME! Tuyeres, Tuyere Cocks, Regulators, Traps, Etc., Etc. Send for Catalogue.

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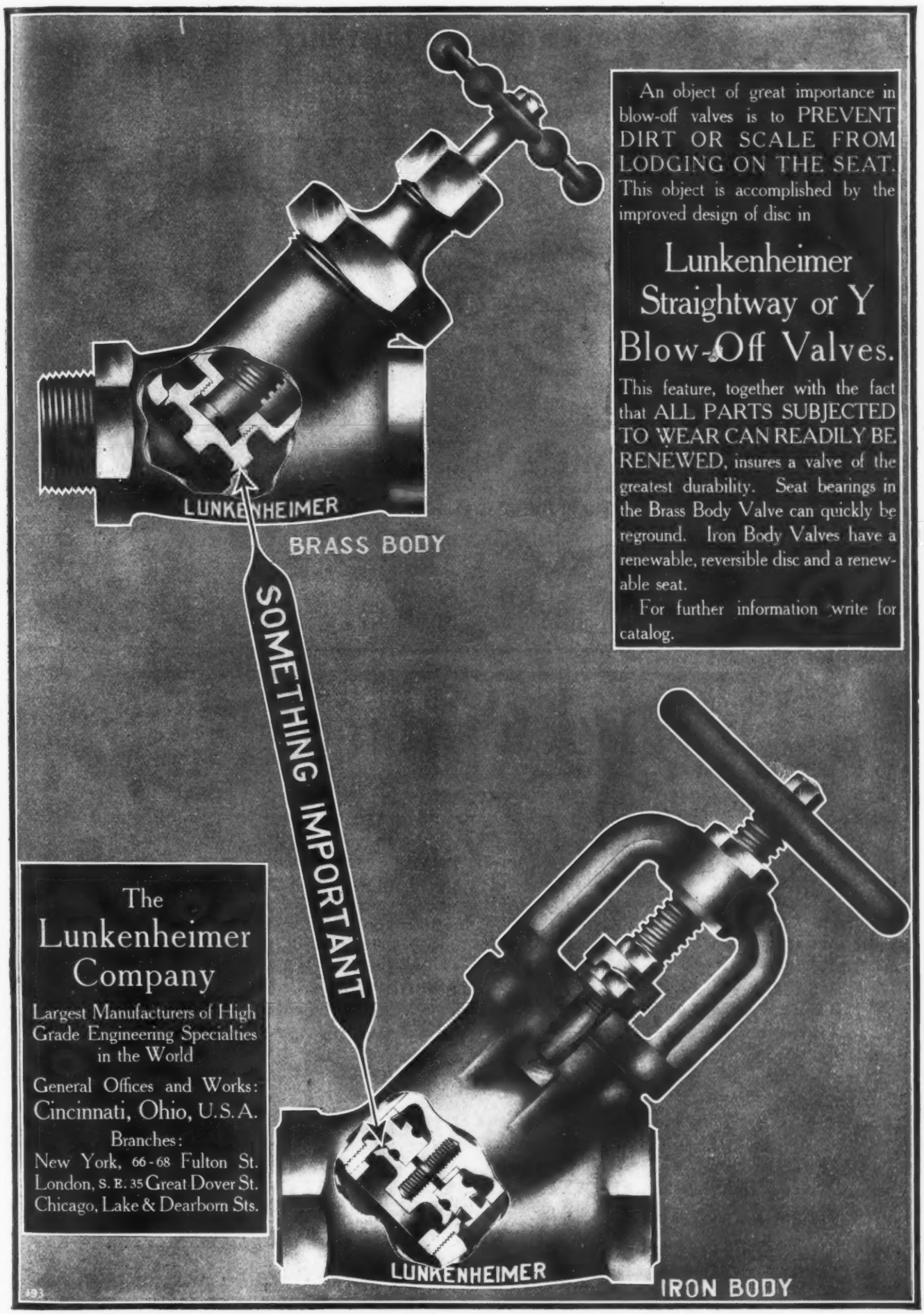

An object of great importance in blow-off valves is to PREVENT DIRT OR SCALE FROM LODGING ON THE SEAT. This object is accomplished by the improved design of disc in

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This feature, together with the fact that ALL PARTS SUBJECTED TO WEAR CAN READILY BE RENEWED, insures a valve of the greatest durability. Seat bearings in the Brass Body Valve can quickly be reground. Iron Body Valves have a renewable, reversible disc and a renewable seat.

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Because We Claim Them To Be The Finest Product of Their Kind.

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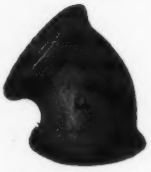

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WE MANUFACTURE ALL KINDS OF VALVES AND FITTINGS. WRITE FOR CATALOGUE.

DAVIS PRESSURE REGULATORS SAVE STEAM

PRESSURE REGULATOR

Do It Automatically

If you are using live steam for heating, drying, cooking or some other purpose at a pressure lower than that carried on the boiler, let the Davis Pressure Regulator make the reduction for you automatically.

This valve can be adjusted to deliver steam at just the pressure needed and it will maintain that pressure without fluctuations no matter how much the initial boiler pressure may vary.

Reducing steam by throttling through a cracked globe or gate valve is about as satisfactory as using saw dust for fuel. You may be able to get along after a fashion, but why not do it right—automatically.

If you are running your engine non-condensing a Davis Automatic Back Pressure Valve will enable you to make use of the exhaust steam instead of letting it go to waste.

Contrast this valve with its semi balanced disc, small weight and noiseless operation without any possibility of injury to the seats, with the old style single seated valve which pounds like a trip hammer and keeps you poor buying seats for it. Is there any comparison—would you choose the single seat ?

Send for a complete catalog of Davis Valve Specialties. It is of interest to both owner and operator.

G. M. Davis Regulator Company,

142 Milwaukee Ave., CHICAGO.

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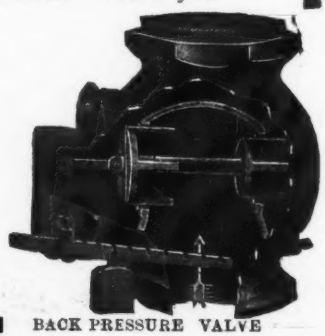
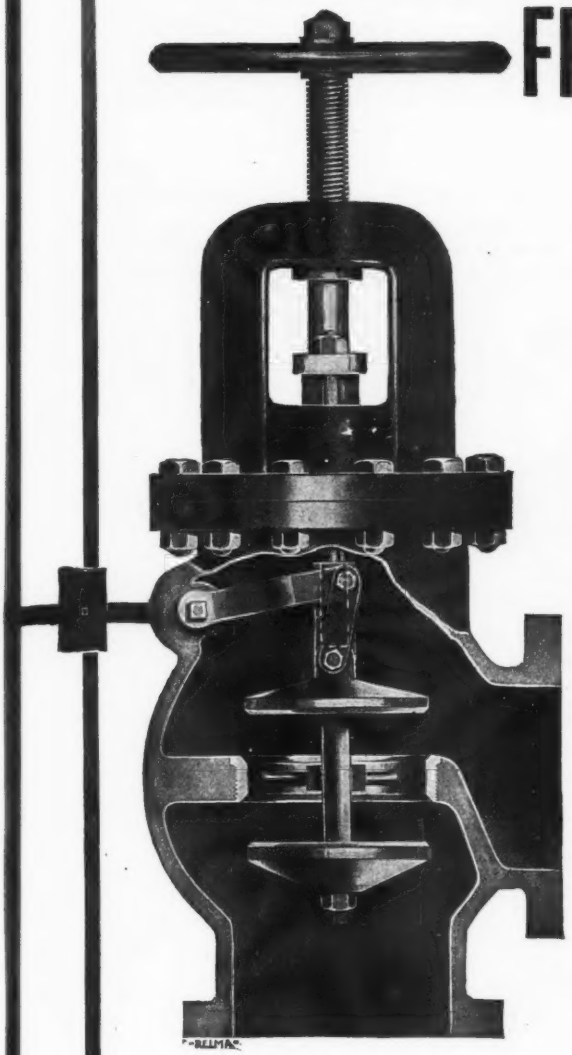


BACK PRESSURE VALVE

PROTECT LIFE AND PROPERTY FROM ESCAPE OF STEAM



There are about four hundred serious boiler accidents in this country every year. Here is a description of one from a recent Hartford report:

> *"(311.)—A flue failed on November 11, in one of the boilers of the — — building at Cleveland, Ohio. Fireman — — was scalded so severely that he died in a short time, and engineer — — was badly burned and scalded while endeavoring to draw the fires. About two weeks previously a steam pipe in this same boiler room burst, and engineer — — was quite severely scalded while closing a stop valve."*

You Can't Tell Whose Boilers Will Go Next

Experience shows that boilers and steam mains supposed to be safe frequently give way. It is poor policy toward your men and toward your property to run a risk when you can positively eliminate danger by equipping your boilers with

THE LAGONDA AUTOMATIC CUT-OFF VALVE

The LAGONDA is the only valve that works both ways, and does not depend upon pressure difference for its action. When once set for a given flow of steam it closes when the flow exceeds that amount. In other words, if the steam main bursts, the cut-off valve on every boiler connected thereto will close, and if a boiler tube bursts, the valve on the injured boiler closes while the other boilers go on supplying steam.

Non-Return Valves close only in the latter case, but the LAGONDA VALVE surely and completely stops the flow of steam in every case of accident.

Get a LAGONDA AUTOMATIC CUT-OFF VALVE on trial. If it doesn't do what we say, you can send it back. Write for Cut-Off Valve Bulletin.

THE LAGONDA MFG. CO., Springfield, O.

Makers of Weinland Boiler Tube Cleaners and Lagonda Reseating Machines and Tube Cutters.

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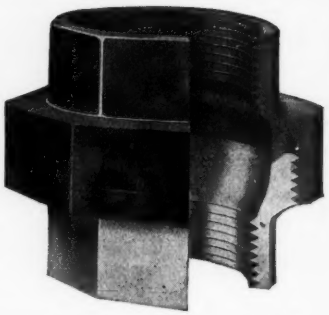
[65]

A UNION OF 3 PARTS



The "Kewanee" Union; the *ideal* union for close work. "Octagon" Pattern. No nipples or gaskets necessary. Ball-joint seat, brass-to-iron contact and thread connection. Never rusts or corrodes. Stands the air pressure test.

Write for full story.

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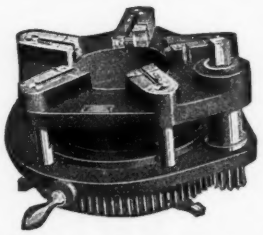

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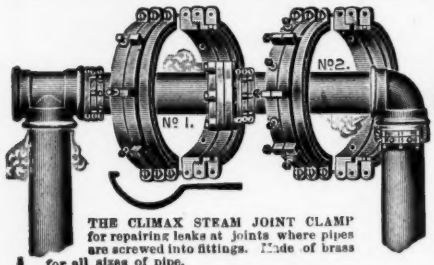
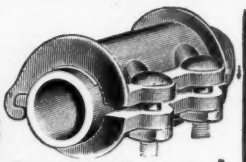
"TOLEDO" Pipe Threading Devices

thread pipe up to 12". ONE MAN can do it quickly and *in any place, in any position.* An invaluable line of tools. Let us tell you about them.

The Toledo Pipe Threading Machine Co., TOLEDO, OHIO.



THE CLIMAX STEAM JOINT CLAMP for repairing leaks at joints where pipes are screwed into fittings. Made of brass for all sizes of pipe.



THE EMERGENCY PIPE CLAMP, for repairing splits and rust holes. Made of malleable iron from ⅛ in. to 12 inches.

PIPE REPAIRS FOR ANY CONDITION

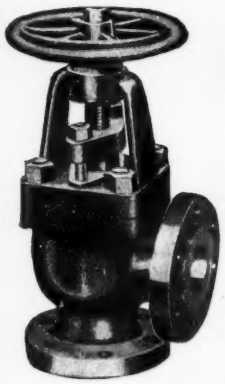
Send for Catalog of

STEAM SPECIALTIES

JAMES McCREA & CO.,

MANUFACTURERS,

61 West Washington Street, Chicago.



Manufacturers of the

EDWARD VALVE

For High Pressures, Superheated Steam and Water.

THE LAMMERT & MANN

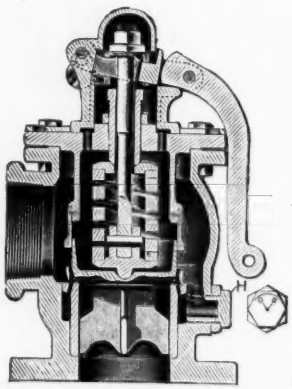
Oil Dash Pots for Corliss Engines, Gas and Gasoline Engines.

LAMMERT & MANN,

ENGINEERS and MACHINISTS,

157 S. Jefferson St. CHICAGO, ILL.

AUTOMATICALLY Adjust Themselves To Wear



ASHTON LOCK UP REGULATING VALVES

consequently last longer without repairs.
We send them on trial.

WRITE FOR OUR CATALOG.

THE ASHTON VALVE CO.

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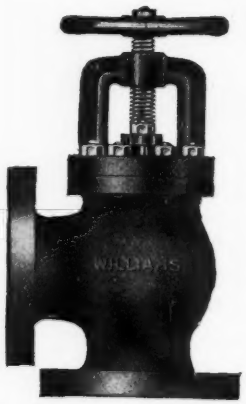
St. John's House, London, E. C.

When Other Valves Fail— Order Williams.



IF the valves in your plant are not giving satisfactory service, why don't you install valves you can depend upon? Williams are the valves you should use. They are the reliable kind — the kind that when once placed in operation, will never give trouble ever afterward. As they do not require constant repairs and attention, they are worthy of the consideration of every engineer who wants greater valve economy.

Williams Iron Body Valves

are intended for the most exacting service. Correctly designed, well proportioned, they are much heavier than other valves and are strictly guaranteed for 175 pounds working pressure. If you want to repack them under pressure, you can do so without any danger of being burnt or scalded. If the seat should ever become worn, it is easily reground and a new bearing secured without any extra cost.

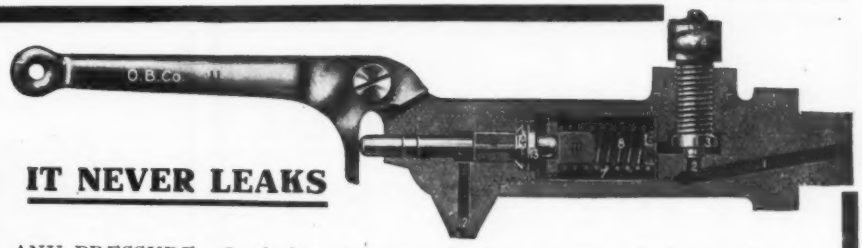
Be wise and order Williams Valves

THE D. T. WILLIAMS VALVE CO.

904-910 Broadway, - CINCINNATI, OHIO

5

COLLIN GAUGE COCK

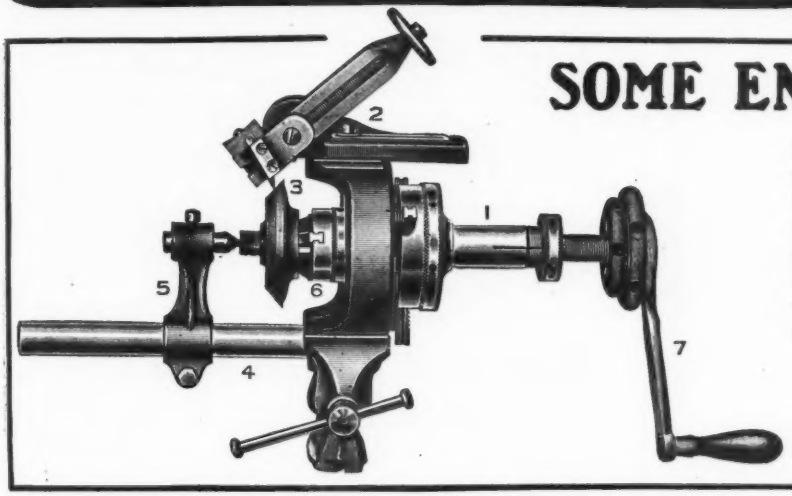


IT NEVER LEAKS

IS ABSOLUTELY TIGHT UNDER ANY PRESSURE. In closing, the piston "13" enters the cylinder, cutting down the velocity of the fluid through the seat "14" and preventing steam-cutting as the valve closes. A slight movement of the lever reduces velocity of discharge and prevents flashing. Made of high grade steam bronze and with or without packless, non-sticking shut-off valve.

WRITE TO-DAY FOR CATALOGUE No. P-F, describing all our steam specialties, including Water Gauges, Gate Valves and Heavy Bronze Fittings and CATALOGUE P-B describing Collin Steam Pressure Regulating Valves.

THE OHIO BRASS CO., MANSFIELD, OHIO. CHICAGO OFFICE 277 DEARBORN ST.



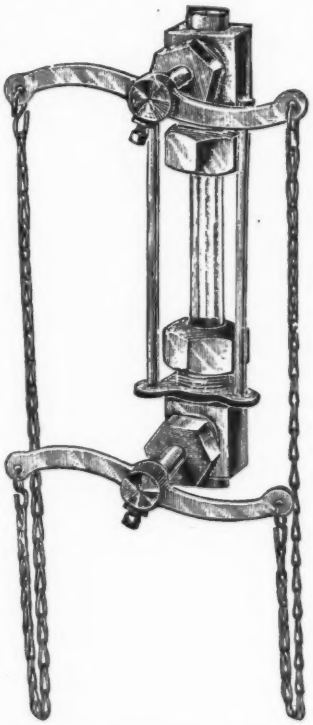
SOME ENGINEERS SWEAR

Or at least feel like it when their valves will not hold steam. That constant sizzle and drip is a disagreeable condition where valves are used with no means of repairing them. These leaky valves can be immediately reseated and made perfectly tight without removing them from the piping, with a **Dexter Valve Machine.**

Catalog P For Asking.

The Leavitt Machine Co.,
Orange, Mass., U. S. A.

SAVED AGAIN



By A Pull On The Chain.

The gauge glass broke but the Engineer shut off the live steam and scalding water at a safe distance by simply pulling the chain.

HE had a **"P. B. H." Quick Closing Water Gauge.**

The **"other fellow"** got badly burned and scalded trying to close the valve.

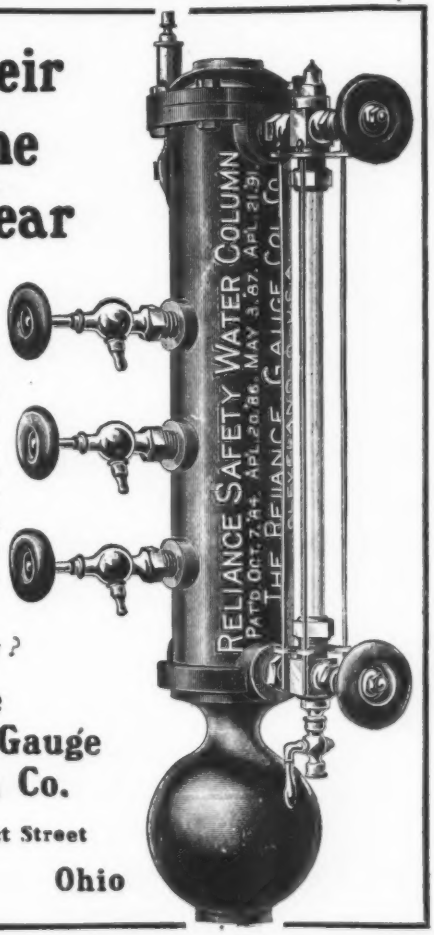
HE used the old fashioned Water gauge.

We'll send a "P.B.H." for 30 days' trial. 'Tis made of the finest stock and lasts indefinitely.

Circular ?

The PAUL B. HUYETTE CO.,
2025 Betz Building, Philadelphia, Pa.

Pay Their Cost The First Year



Reliance Safety Water Columns are the only ones whose operation is permanently successful. They safeguard the boiler, insure dry steam and reduce fuel bills. 55,000 are in active use.

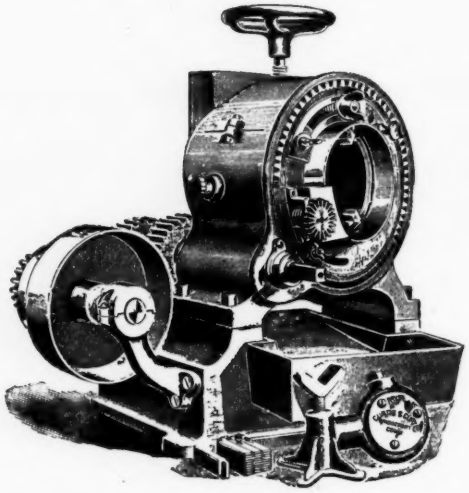
Catalog ?

The Reliance Gauge Column Co.

75 E. Prospect Street

Cleveland, Ohio

This Way Out of Pipe Threading Troubles



The Forbes Patent Die Stock

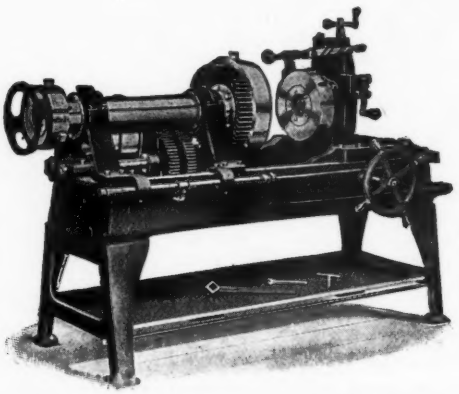
is the only machine having an adjustable shell to compensate for the wear on its gears.

One man with the Forbes can thread or cut pipe up to 15" in record time and be sure of his results.

Another advantage lies in the small amount of space required for operating this machine.

Catalog?

The Curtis & Curtis Co.
85 Garden St.,
Bridgeport, Conn.



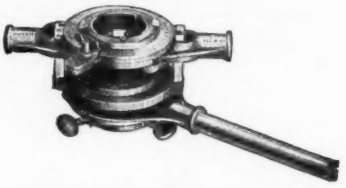
GOOD THREADS

may not be an absolute necessity if you use plenty of cement, yet there is no denying the fact that it is *better* to have *good* threads. Some may be satisfied with poor threads, but if you are a sticker for good ones, do your threading on a B. & K. PIPE MACHINE. *Yours for good threads.*

Bignall & Keeler Mfg. Co.
Edwardsville, Ill.

"BEAVERS"
are the proper die stocks for use about factories

BECAUSE they are built on the easy working principle, enabling one man to thread any size pipe without calling for help.
Each Stock threads all sizes of pipe within its range without changing dies so you have no loose parts to carry around or get lost or misplaced.
And consider the time you save by not having to change dies.
They are a time proven success and of such practical advantage in saving time and labor as to compel their use from an economical standpoint once you realize it.



"Beaver" 1" to 2" Ratchet Stock.

Made in all sizes ¼" up.
Sold by all Jobbers subject to 10 days' trial.
We would like to send you descriptive matter.

THE BORDEN COMPANY
WARREN, O.

Stulp Automatic Safety Water Gauge

automatically grinds it own valve seats and cleans its way to the boiler. Approved by the U. S. Board of Supervising Inspectors of Steam Vessels.

Awarded Diploma and Medal at Jamestown Exposition.

The Automatic Safety Water Gauge Co.

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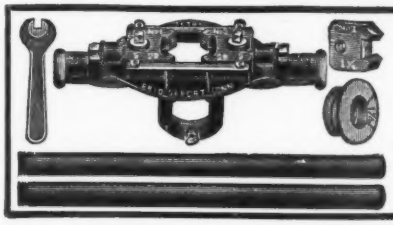
Erwood Swing Gate Valves

Manganesite Paste for Joints

WALCH & WYETH, 87 Lake St., Chicago.

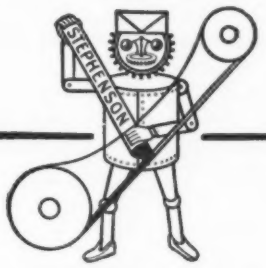


STOCKS AND DIES
PIPE MACHINES,
PIPE CUTTERS,
VISES.

Manufactured by

The Armstrong Mfg. Co.
287 Knowlton St.,
BRIDGEPORT, CONN.

SAGINAW MANUFACTURING CO.,
SAGINAW, MICH., U S. A.
MANUFACTURERS OF
GILBERT WOOD SPLIT PULLEYS.
New York Branch, 88 Warren Street.
Chicago Branch, 32 South Canal Street.
Sales Agencies in all principal cities.
Cable Address, "Engrave" A. B. C. and Lieber's Code.



THE AFTER EFFECTS ARE PLEASANT

Don't waste good belts and lose valuable power. **STEPHENSON Bar Belt Dressings** contain no Rosin nor any other ingredients injurious to Belting. Our **RED Label** and **GREEN Label Brands** are two entirely different and distinct preparations. No **one** kind of Dressing is good for **all** Belts—you know that. **STEPHENSON Dressing** not only prevents slipping and gives full speed from slack belts, but **the after effects are pleasant**—it KEEPS those belts in good condition and greatly prolongs their life.

This means a saving in BELTING, which is an important item when figuring the year's expenses.

RED Label Brand for Leather belts;
GREEN Label for Rubber and Canvas.

Your protection against substitution is **The Man with the Cog-Wheel Face** on each Pound Stick.

Of Dealers everywhere, or

STEPHENSON MFG. CO.
ALBANY, N. Y

OXoilOX

VIENNOT - PHILA

A GOOD START

is half the battle, and the very best start for *any new belt* is a thorough treatment with OXoilOX—*The Perfect Belt Dressing.* It restores to leather the strength and vitality lost in tanning. Makes belts tough, yet soft and pliable, so that they adhere closely to the pulleys, and slipping is made almost impossible.

OXoilOX is not a *"dope,"* and it doesn't make belts sticky; just keeps them clean and healthy so that they can live out their full life and do a good day's work each day. You can have

A FREE SAMPLE

F. S. WALTON CO., Philadelphia, Pa.

Gentlemen: Kindly send us, free of charge, a sample can of OXOILOX the Perfect Belt Dressing.

Name.....

Address.....

Name of Firm.....

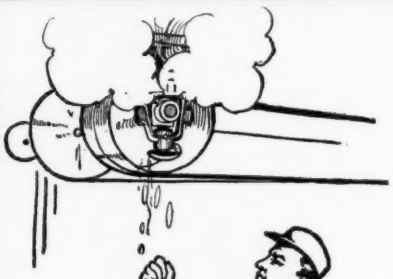
Number of Belts..... Average Size.....

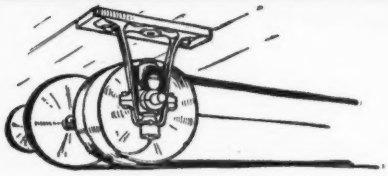
F. S. WALTON CO., Philadelphia, Pa.

Pressers and Refiners of all grades of Neatsfoot oil

THERE IS ONLY ONE

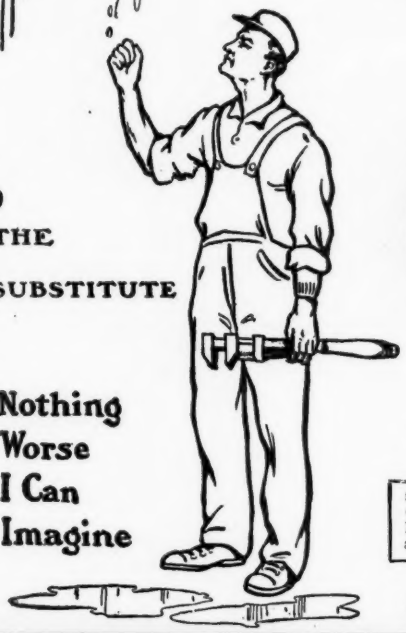
ALBANY GREASE





THE SUBSTITUTE

Nothing Worse I Can Imagine



The only Genuine ALBANY GREASE has this trade mark on every package. Look and ask for it.

Send for FREE sample cup and can of "Albany Grease," giving size of tap for cup, depth of oil hole from top of cap to journal, where to be used and firm's name.

MADE ONLY BY
ADAM COOK'S SONS,
313 WEST ST., NEW YORK.

NOTHING EASIER

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THE ONLY GENUINE

Detroit Improved Standard Lubricator

Some One

of our 337 different styles and sizes of sight-feed lubricators will fill any requirement you may have.

When ordering, insist on getting the genuine Detroit.

Write for a catalog of the most complete line of oiling devices for all purposes.

DETROIT LUBRICATOR COMPANY.
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Robins Laminated Leather Belting

Is made continuous without laps, plies or cement. Guarantees an equal distribution of strength and an uninterrupted line of power transmission.

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RHOADS LEATHER BELTING

Not merely weight but work tells the tale.

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THIS SHULTZ SABLE BELT

will transmit from 25% to 33% more power and give longer service than ordinary oak-tanned belting. Ask for our Belt Book No. 4. Get a Shultz Sable Belt for 60 days' free trial.

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29a

To - - - - - Lubricating Oil
Add - - - - - Dixon's Flake Graphite

The result is - Perfect Lubrication

By filling up all irregularities in the rubbing surfaces DIXON'S FLAKE GRAPHITE imparts a smoothness on which a small quantity of oil has more lubricating effect than could be possibly attained with any quantity of oil alone.

WRITE FOR A FREE SAMPLE CAN NO. 94-C.

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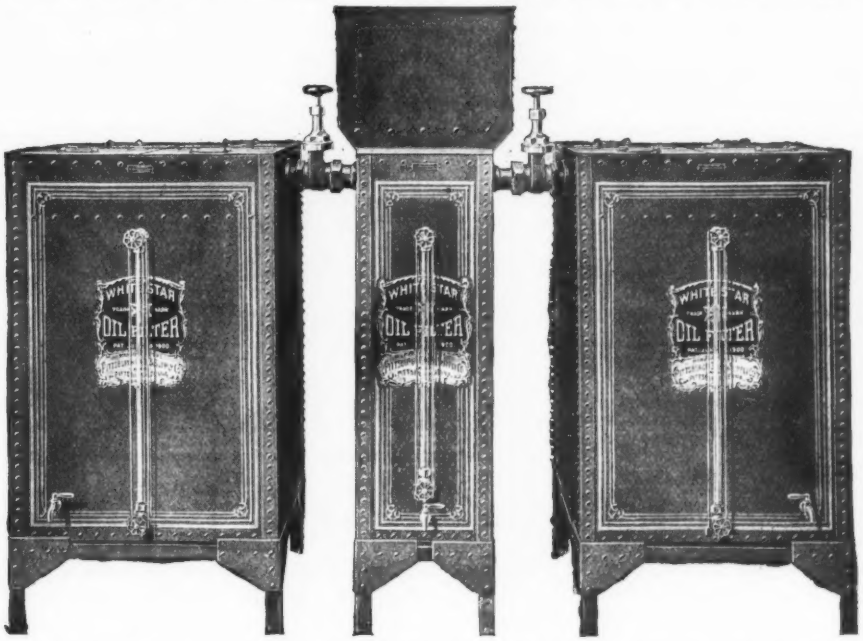
WHITE STAR OIL FILTER

MULTIPLEX TYPE—Used exclusively in oiling systems of the largest capacities.

Will take care of any amount of oil.

Nothing too large.



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Our catalog "D" treats fully the subject of Engine Lubrication—Send for it.

Pittsburgh Gage & Supply Company, Pittsburgh, Pa.

We furnish

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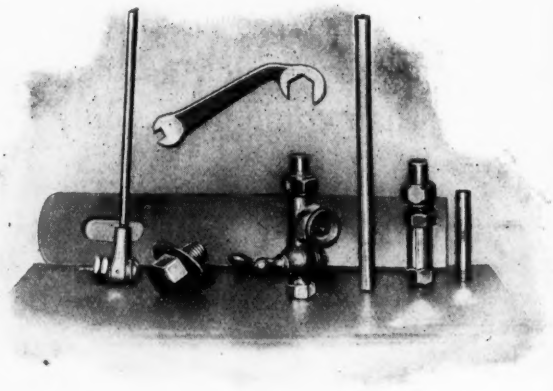
with each Latest Improved

ROCHESTER

Automatic Lubricator, all the necessary pipe and fittings for attaching to the engine.



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Greene, Tweed & Co.,
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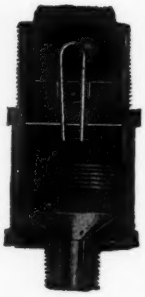
The "Philadelphia" Grease Cup



Automatic application of grease to the bearing without the use of spring compression. : : : :

Nature Supplies the Feeding Force in the Form of Compressed Air. : : : : : :

With many thousands of the "Philadelphia" Grease Cups in successful operation, on machinery of almost every description, we offer a system of lubrication which, for simplicity, cleanliness, economy, reliability and efficiency has no equal.

The "Philadelphia" Cup is not merely "as good as any other:" IT IS THE BEST, and we are prepared to prove our claim for actual superiority. There are more reasons for its practical success than we have room to mention here.

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The Philadelphia Lubricator & Manufacturing Co.
The Bourse (Exhibition Dept.), **Philadelphia, Pa.**

Pyramid Boiler Compound

dissolves boiler scale and prevents the formation of more.
It is *guaranteed* to make clean boilers. Ask for details.

Binghamton Boiler Compound Co.,
BINGHAMTON, NEW YORK.

Los Angeles, Cal.; Seattle, Wash.; Portland, Oregon, Cincinnati, Ohio; Cleveland, Ohio; Providence, R. I.; Syracuse, N. Y.; Scranton, Pa.; Louisville, Ky.; St. Louis, Mo.; Birmingham, Ala.

THE HAWK-EYE BOILER COMPOUND

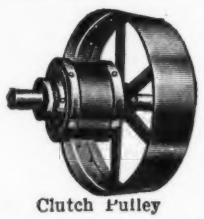
NEVER FAILED.
See our Advertisement in First Issue Every Month.

HAWK-EYE COMPOUND CO.,
303-304-305 Merrick Block, CHICAGO, ILL.

"Operates 3,000 Times A Day"

So writes one user of the

Akron Clutch



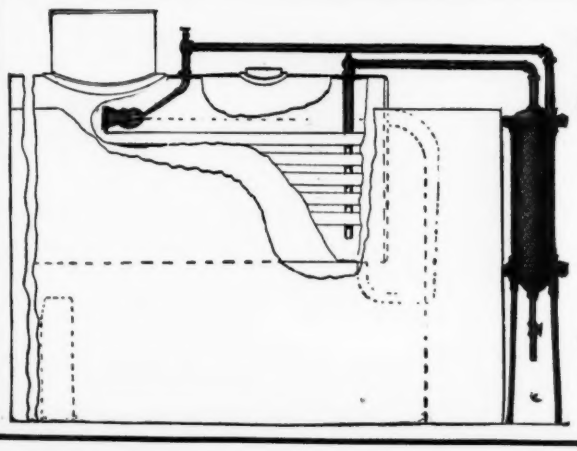
Clutch Pulley

Clutch Coupling

We have further proof that it's the best friction clutch made. Do you want it?

THE WILLIAMS FOUNDRY & MACHINE CO.,
Akron, O.

Successors to the Akron Clutch Co.



NO MORE SCALE

Will Ever Form

in your boiler after you install a Buckeye Boiler Skimmer on trial, because after trying it you will never let it go and as long as you keep it scale cannot form. Ask for proof.

The Buckeye Boiler Skimmer Co.
Colburn Avenue, TOLEDO, OHIO.

HOW DO YOU GET RID OF SCALE?

¶ Some engineers suggest purifiers because their theory looks good. Others say mechanical removal because it seems to be a necessity. Those who still had troubles after trying both and who then used

BIRD-ARCHER COMPOUNDS

now stick to the compound because they KNOW it does the work. No hard work, no shut-downs, no leaky tube ends, no wasted coal—all savings effected by the Bird-Archer method. If Bird-Archer Compound does not remove the old scale, and prevent new, and do it without harm to the boilers or fittings, you can have your money back. Send for our free book "Boiler Troubles and Their Prevention." 12

THE BIRD-ARCHER CO.,
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No Freezing Here

The Drip Cock prevents it

U.S. Automatic Injector

The Drip Cock of the U. S. Automatic prevents freezing; prevents overheating of suction pipe; prevents jet "liming up" when steam or check valve leaks; *prevents destruction of hose on traction engines* by heat from hot water, and has many other exclusive advantages fully explained in our

Engineer's Red Book

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AMERICAN INJECTOR CO.
Detroit, Mich., U. S. A.

Chicago Automatic Injector

Chicago Automatic Injectors

Prove their Quality in Actual Operation

No boiler feeding troubles when you have a powerful Injector that is built for service.

The Chicago Guarantees a Full Boiler when you want it

It is positive in its work and has nothing to get out of order. Built unusually strong.

THE BEST PROTECTION FOR BOTH BOILER AND ENGINEER

You cannot afford to be without it. It makes the power plant complete.

THE CHICAGO EJECTOR, a powerful little instrument for elevating, forcing and conveying liquids. Does marvelous work with but little steam.

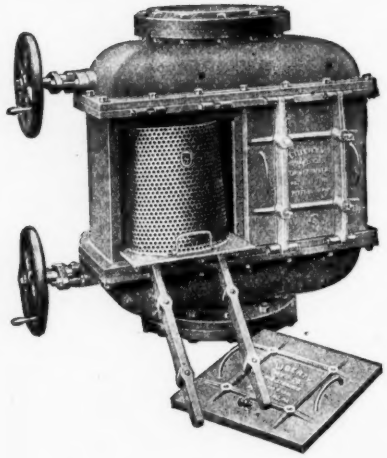
Write for description and catalog of both the Chicago Injector and Ejector.

THE OHIO INJECTOR COMPANY,

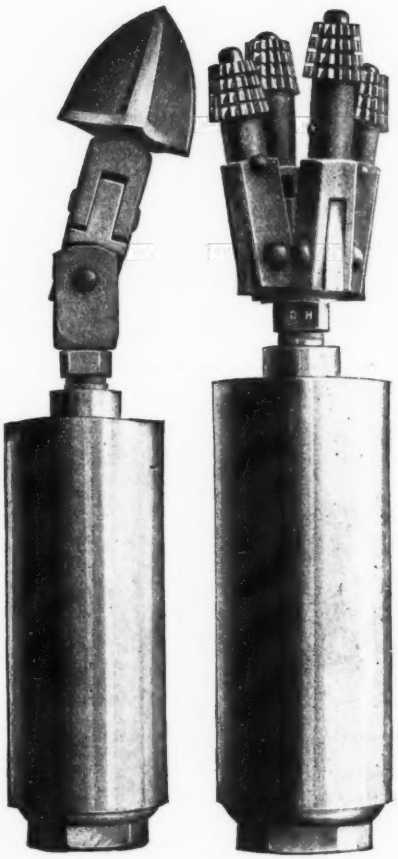
The World's Greatest Injector Manufacturers.

WADSWORTH 110 Main Street OHIO, U.S.A.

Chicago Ejector



Eternal Vigilance
The Price of
Power Plant Peace!



WHERE Liberty Devices are on guard there is little danger of trouble in the power plant. The Twin Strainer is always at work, for even if one side is being cleaned the other side continues to work.

The Turbine Cleaners by cleaning tubes at twice the ordinary cleaner speed, make possible a frequent use without loss of time, thus keeping the tubes always clean and saving fuel.

The Liberty Oil Purifier is a small refinery which does not depend on filtering material and consequently works more steadily without attention.

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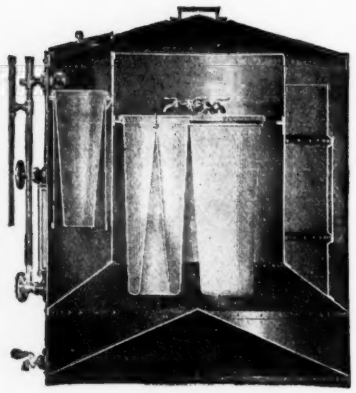

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A NEW DEPARTURE

All Forged Steel
Case-Hardened

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The Movable Jaw Extends Outward Instead of Toward the Handle, Therefore The Larger the Nut the Longer the Leverage

THREADS IN BOTH NUT AND JAW ARE ROUNDED THUS PREVENTING STRIPPING

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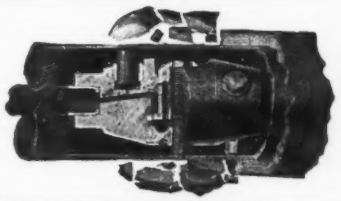
THE "TORPEDO"
Removes all scale from tubes of fire tube boilers.
Saves 11 per cent. of fuel for each 1-16 inch of scale.
Prolongs life of tubes.
Saves compound.
Centers itself in tube.
Strikes same in every direction.
Stroke limited and cushioned.
Does not hammer but vibrates the tube.
Is absolutely safe and easily operated.
Has but one moving part.
Will last a lifetime.



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THE IDEAL CLEANER FOR FIRE TUBE BOILERS.

We invite every plant using fire tube boilers to send for a "TORPEDO" on free trial. If it isn't the best cleaner you ever saw, don't buy it. Every engineer should have a copy of our free circular No. 30. "How to Tell a Good Fire Tube Cleaner." For water tubes, send for circular No. 54 on straight tube, or No. 56 on curved tube "DEMON."

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Some Dealers buy an imitation—you know why!

Isn't this just what you have looked for ?

The COMBINATION
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The *chilled* scraping edges are more *durable* than steel. The *protected* spring makes it *self-adjusting*.

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at a price $50 below that of any other standard device for the purpose. It will cost you nothing to try it. *Write.*

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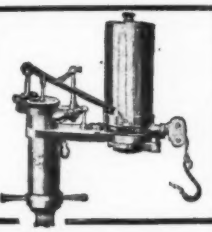

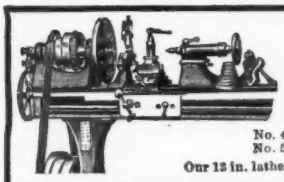

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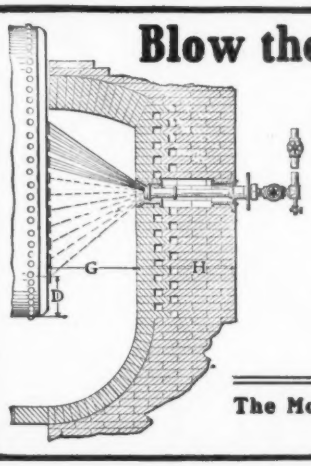

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With a Monarch Steam Flue Blower.

Then you'll have clean tubes in five minutes.

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No Baffle Plates

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and consequently no back pressure.

Gardner Exhaust Heads

cause the steam to revolve horizontally so that gravity can remove the oil and condensation. Write.

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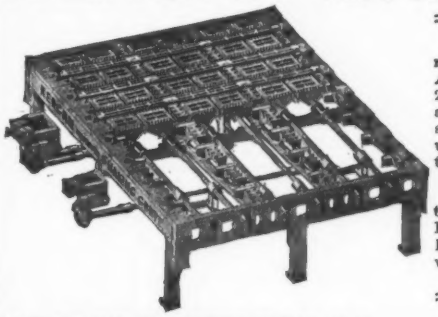

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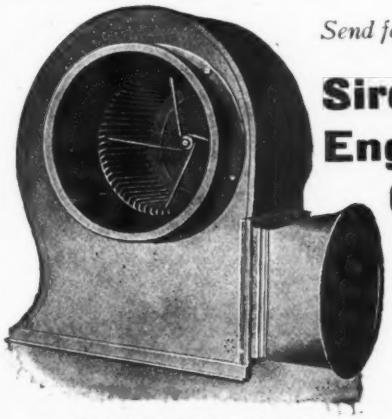

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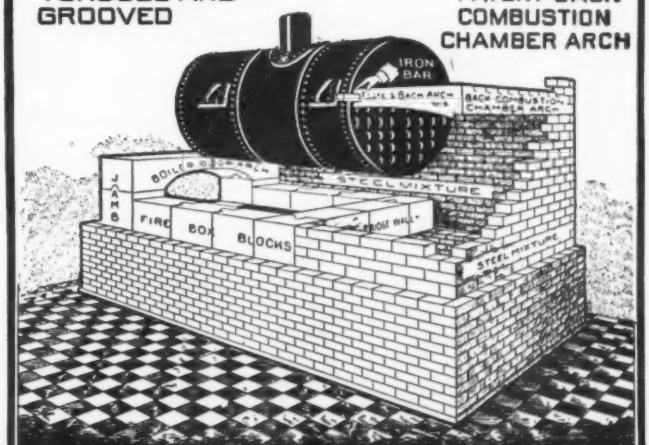

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burns slack and other low cost fuels with unexcelled economy and absolute smokelessness. Strictly automatic in feeding and distribution of coal and the removal of the ash. Send for a complete description.

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FOR POLISHING GOLD, SILVER, PLATED WARE, NICKEL, TIN, BRASS, COPPER, Etc.
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THE ONLY METAL POLISH

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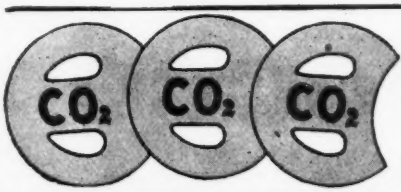

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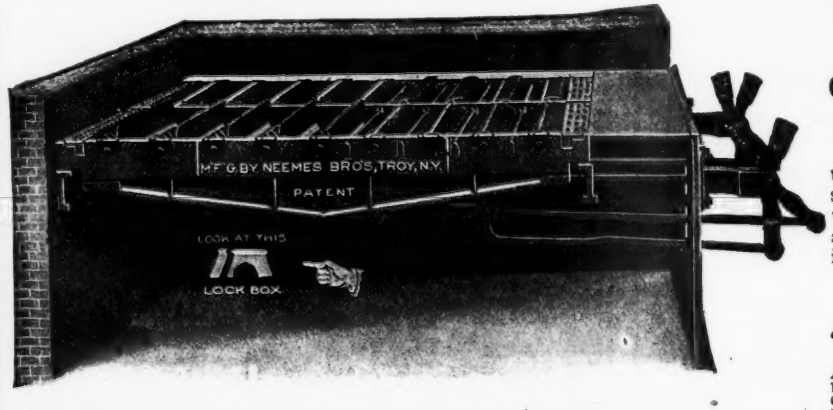

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Clinker Cutting, Shaking and Dumping Grate

unlike all other grates will cut from both sides of the shaker alike. Makes more steam with cheaper fuel and less of it. A slight agitation shakes out the ashes or a full opening dumps everything into the ashpit. *Write.*

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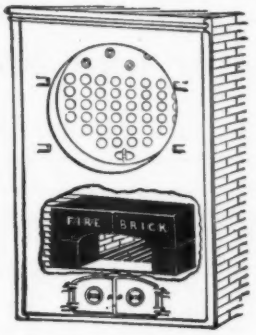

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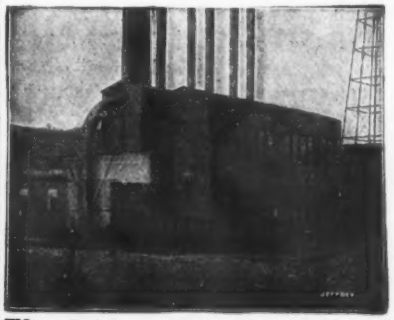
A MODEL POWER HOUSE EQUIPMENT

Employing Jeffrey Machinery



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Hoppers with Pivoted Bucket Conveyer for handling coal and ashes.

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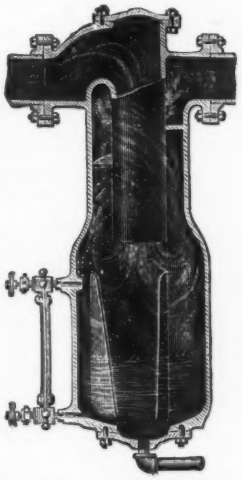
by an excess of water being carried into the cylinder? It would be interesting to know, because it is absolutely inexcusable when the use of a



Stratton Separator Assures Absolutely Dry Steam

no matter how much the boilers may foam, or how long a pipe line is exposed to cause condensation. If the cut doesn't explain it our catalog will.

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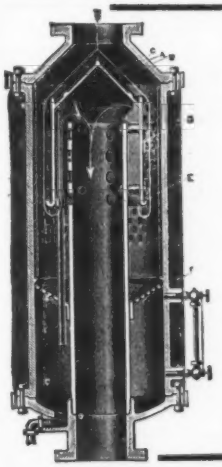

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Steam Separators deliver 99.8 dry steam and oil separators remove 99% of oil from exhaust steam. They *do* it that's all. All styles.

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Will prove Baum Separator supremacy more surely than the best argument man ever has or ever could write.

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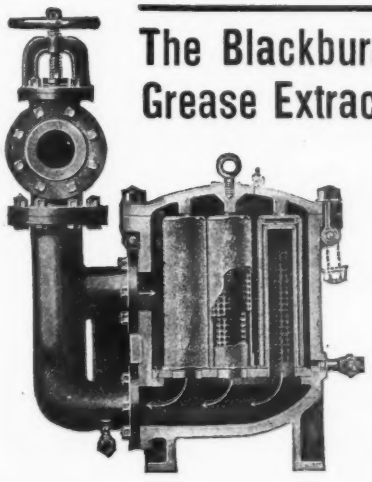

The Blackburn-Smith Feed Water Filter and Grease Extractor in the Feed Line

is the best possible defense against getting oil, grease, or mechanically suspended particles into the boiler. No line separator removes all oil from the exhaust and open heaters often let oil get to the boilers. Where such apparatus is used the Blackburn-Smith Filter offers a final and effective protection by double filtering every drop of water through separated Terry cloths.

Write for booklet "Feed Water Filtration"

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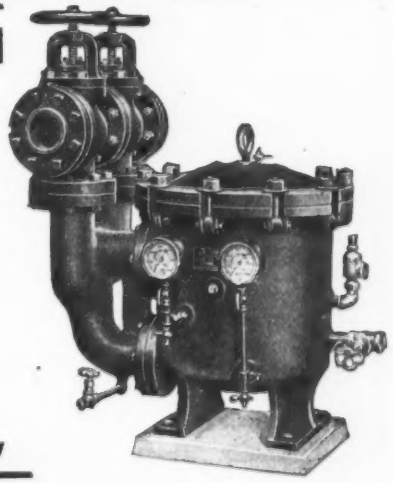

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The Wilkinson Automatic Stoker and Smoke Preventer

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LONG EXHAUST LINES AND VACUUM OIL SEPARATORS WITHOUT BREAKING THE VACUUM.
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The Anderson Improved Steam Trap

End all Condensation Troubles

save equipment repairs, save steam, save the engineers' time, all of which added equals a saving of many times its own cost. Ask for the "Trap Book."

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TRY ONE!

Convince yourself that the GEIPEL STEAM TRAP does save steam.

Made in Seven Sizes for All Classes of Service.

Descriptive Circulars on Request.

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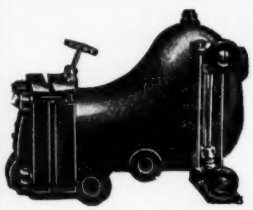

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are especially adapted for draining steam separators and high pressure mains. Also good for steam heating. All working parts are attached to the bonnet, and are removable with it. Valve outlets are large, to give rapid discharges of condensation.

Watson Steam Pump Governor

should be used on all steam pumps where a fixed discharge pressure is desired.

The construction permits of easy access to the stuffing box for removing packing, and the spring can be adjusted or entirely removed without interfering with any other part of the valve. Any practical man will readily see its advantages.

All our goods are made in our own factory and tested before shipping. We guarantee them to give perfect satisfaction. Established 1878.

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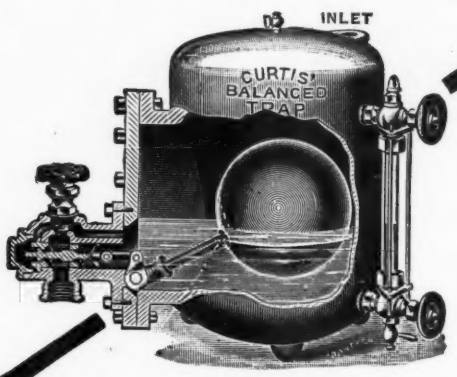

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who has a CURTIS BALANCED TRAP working for him. Its sure, positive action and absolute accuracy make it invaluable wherever a trap is needed—absolutely reliable under all conditions, works under any pressure up to 250 pounds.

Do you know the CURTIS SPECIALTIES? Write for copy of latest catalog.

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Progressive Steam Economy With

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Steam Traps
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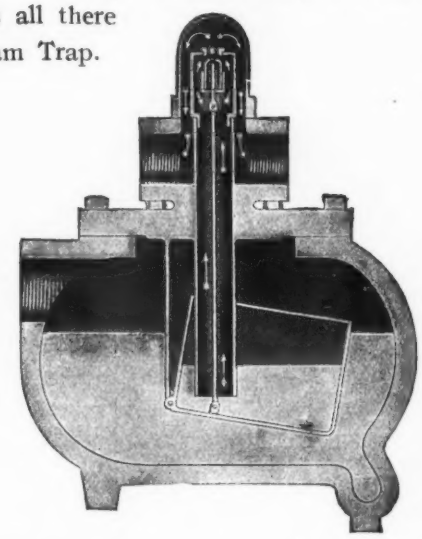
An open cast-iron bucket, a brass stem and a government bronze valve and seat encased in an extra heavy body is all there is to our Steam Trap.



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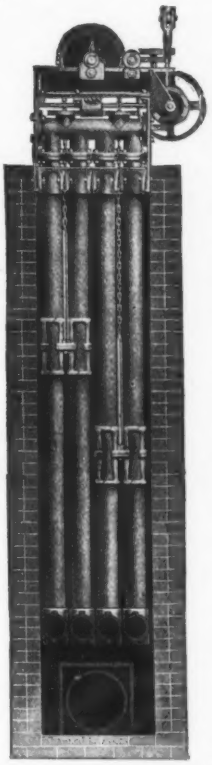
54 No. 6th St., Philadelphia. 88 Broad St., Boston. 261 Centre St., New York.

Heating Buildings by Hot Water or Air Free of Cost



Nearly every factory, or indeed every large building, wastes heat in some form, either in the flue gases from boiler or other furnaces or in exhaust steam. As long as heat escapes, it is a down-right waste to burn good fuel for heating, ventilating or drying purposes.

The heat in waste gases may be recovered by the Green Fuel Economizer for hot water heating or for supplying hot water for industrial purposes, as washing, dyeing, etc., while by means of the Green Waste Heat Air Heater, this heat can be recovered for drying and heating and ventilating, as in laundries, textile mills, shops and other places where heated air is to be used at a point not too remote from the furnace.

Exhaust steam can be utilized for heating air for all purposes by conducting the steam into Green Patent Heaters and blowing air over the latter by means of Green Fans, Blowers or Exhausters.

We have a special booklet relating to the applications of Green apparatus for the utilization of waste heat in all of the above ways, in brick and tile yards, office buildings, factories, gas plants, lumber kilns, laundries, baking powder factories, glue factories, malt houses and breweries, paper mills, etc., etc.

Write us, giving particulars as to your plant, and we will send you a preliminary lay-out and estimate.

Ask also for our general catalog "P."

The Green Fuel Economizer Co.
Matteawan, N. Y.

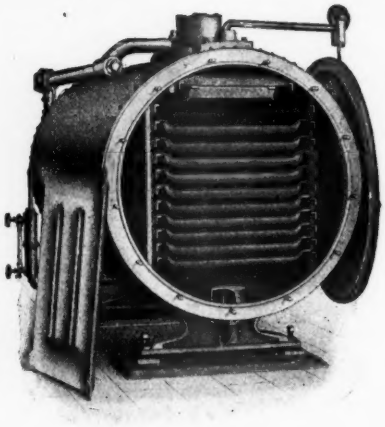
New York City, Boston, Chicago, Atlanta, San Francisco, Los Angeles, Seattle, Salt Lake City, Montreal.

Engineers; Builders of Green's Fuel Economizers, Fans, Blowers and Exhausters, Steam Air Heater Coils, Waste Heat Air Heaters, Mechanical Draft, Heating and Ventilating and Drying Apparatus, Draft Dampers and Engines.

142

EXHAUST STEAM

will heat your feed-water to the highest possible temperature obtainable from exhaust steam because they bring the water into contact with the steam in thin films on a most extensive heating surface and the depositing of scale-forming solids on the heating surface in no way retards the heating action of the steam.



Hoppes Heaters are built in both Steel and Cast Iron construction and with or without water storage capacity as conditions may require. Every one is equipped with an efficient oil extractor and balanced, automatic regulating valve for controlling the raw water supply. They are no experiment but an apparatus tested by years of practical service in steam plants throughout the whole world and are *guaranteed* to give satisfaction.

FEED-WATER HEATERS

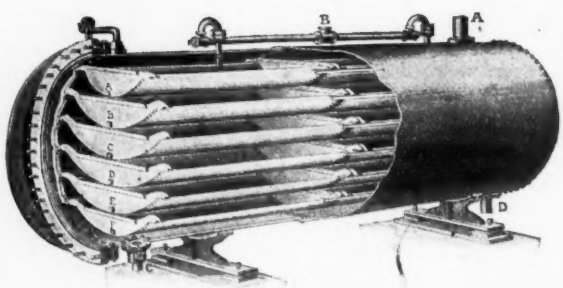
STEAM and OIL SEPARATORS EXHAUST HEADS

HOPPES

SEND FOR CATALOG

LIVE STEAM

"An ounce of prevention is worth a pound of cure" and a Hoppes Live Steam Feed-Water Purifier is the most economical and efficient preventative of scale in boilers. They remove the scale-making solids from the feed-water at the proper time—before they enter the boiler—and also do away with the useless expense of chemicals.



If you are troubled with boiler scale, send us a quart sample of your feed-water by express, prepaid, stating capacity of your boiler plant, and we will submit you a proposition on a Purifier together with blueprint, specifications and guarantee of what it will do for you.

FEED-WATER PURIFIERS

THE HOPPES MFG. CO. 19 LARCH ST. SPRINGFIELD, O.

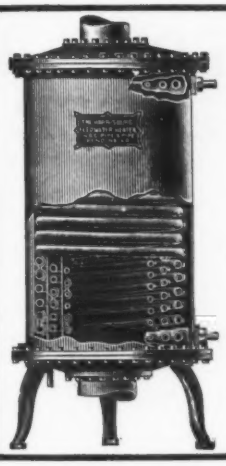
MEASURE IT

You would not think of buying lumber or oil by guess, why be less wise about steam, air, water, etc, which the St. John Meter will measure accurately for you ?

WRITE TO-DAY.

G. C. ST. JOHN,
140 Cedar Street,
NEW YORK.

The St. John Indicating and Recording Steam Meter



HARRISBURG FEED WATER HEATER

of Pure Seamless Copper Coils

Guaranteed to be the most effective, most durable and cheapest heater manufactured.

COPPER, IRON AND BRASS PIPE

Coils and Bends of any desired shape. Manufacturers of High Grade Wrought Iron Pipe, Black or Galvanized. Write for descriptive catalog.

Manufactured by

The Harrisburg Pipe & Pipe Bending Co.
950 Herr Street, HARRISBURG, PA.

Over 1000 Central And Electric Stations Supplied

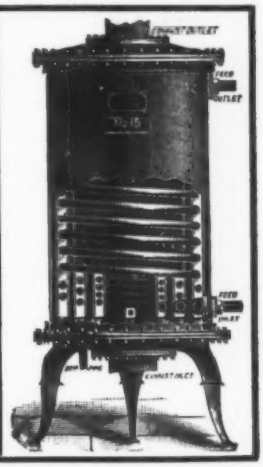
The National Feed Water Heater

is inexpensive to buy and much cheaper to maintain than any other heater of like capacity. Boilers agregating 2,500,000 H.P. are depending on these heaters for a large part of their efficiency. *Write.*

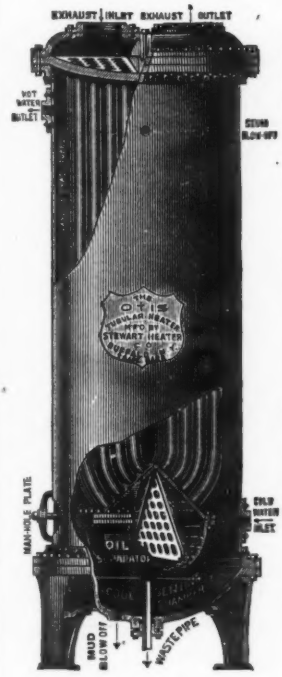
The National Pipe Bending Co.,

175 Lloyd Street, New Haven, Conn.

120 Liberty Street, New York. 54 High Street, Boston, Mass.



The Cleaner the Hotter



No Feed Water Heater can do satisfactory work when a quantity of dirt has settled among the tubes.

The Otis Tubular Feed Water Heater, Oil Separator and Purifier

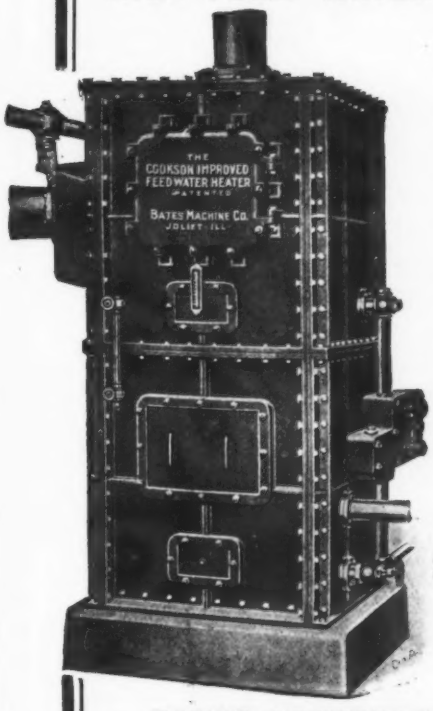
is so constructed that sediment settling among the tubes encounters the sloping tube plate and rolls off to fall into the settling chamber.

Write.

The Stewart Heater Company

45 E. Delavan Ave., Buffalo, N. Y., U. S. A.

COOKSON STANDARD ALL CAST IRON FEED WATER HEATERS



Highest Temperature and Positive Purification of feed water.

Perfect Separation and Removal of Oil.

Automatic Control of Cold Water Supply.

Dry Steam for Heating Purposes.

Finest Grade Special Fittings.

Lime Catching Pans. Especially Adapted for use with Heating Systems, Dryers, Etc.

Write for our new Heater Catalog.

BATES MACHINE COMPANY
Sole Manufacturers **Joliet, Illinois**

A HEATER WITHIN A HEATER

The steam heated outer shell prevents any loss of heat by radiation thus making the

Baragwanath Steam Jacket Feed Water Heater

the most efficient, economical device ever contrived for this purpose.

Over 5000 in use, some of them giving satisfaction for more than 30 years.

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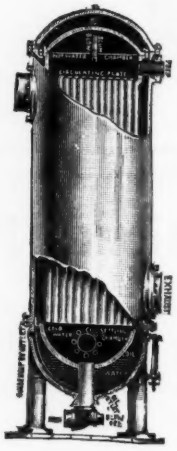
WM. BARAGWANATH & SON,
54 West Divison St.,
CHICAGO, ILLINOIS, U. S. A.
Thos. B. Whitted, Piedmont Bldg., Charlotte, N. C., Southeastern Manager.

RIBLET FEED WATER HEATERS



Built of the best obtainable materials and by designs which provide for perfect circulation for both water and steam, safe expansion and easy cleaning.

The entire tube system can easily be removed and replaced without disconnecting the heavy pipes.

CATALOG?

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1203 PEACH ST., - ERIE, PA.

It's Like Finding Money

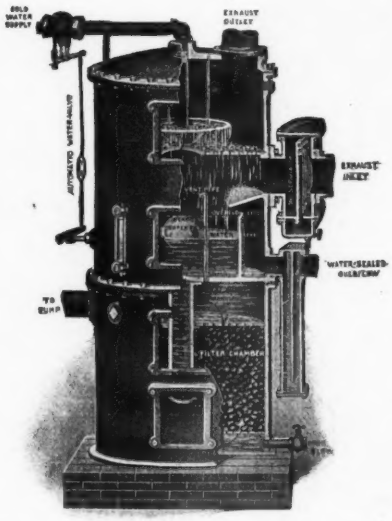
to install the LOEW FEED WATER HEATER. It gives the exhaust steam a *financial value* and reduces fuel bills about 15%.

Some distinctive "Loew" advantages are: The thorough mixing of the water, thus equalizing the temperature. The 6-pass feature, which means that the water passes *six times* through the exhaust steam. The absence of unequal expansion or strain, the ease of cleaning and the total elimination of leakage.

WRITE FOR CATALOG.

THE LOEW MFG. CO.,
CLEVELAND, OHIO.

THE WHITLOCK OPEN EXHAUST Feed Water Heater and Purifier

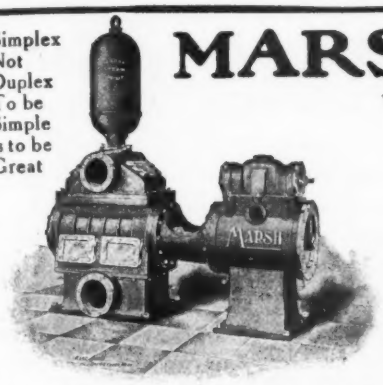


Perfect Oil Separation. Easily Cleaned. The Highest Possible Temperature in the Feed Water.

Manufactured by

THE WHITLOCK COIL PIPE COMPANY
HARTFORD, CONN.
New York Office—Singer Building, 85 Liberty Street.

Simplex Not Duplex To be Simple is to be Great



MARSH BOILER FEEDERS

are designed for handling hot as well as cold water. They are *at regular prices* fitted with bronze Piston Rods, bronze Water Cylinder Liners held in place by Studs, bronze Valve Seats, Stems, Nuts and glands. THE BEST OF MATERIAL AND THE BEST OF WORKMANSHIP ONLY GO INTO **MARSH PUMPS.**

Write for Catalog 17-G.

American Steam Pump Co., Battle Creek, Mich.

The Reilly Multicoil Heater

Used by the U. S. Government because it is the lightest, most efficient, and the best designed feed water heater.

It costs no more than less efficient types. It gives better and longer service than the most expensive. We recommend using a thermometer to prove our guarantees.

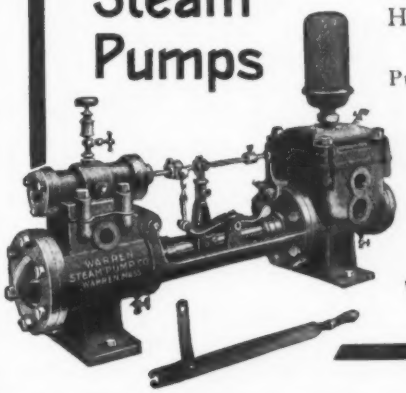
THE GRISCOM-SPENCER CO.
90 West Street, New York
STEAM BOILERS — ENGINES — TANKS
THE REILLY GREASE EXTRACTOR AND FEED WATER FILTER

Steam Pumps

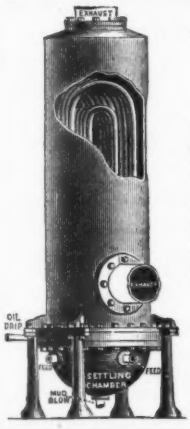
of the Highest Class.

Repairing of Pumps a specialty.

Send for Catalog.



Warren Steam Pump Co.,
Warren, Mass., U. S. A.



Almost Boils The Water With Exhaust Steam

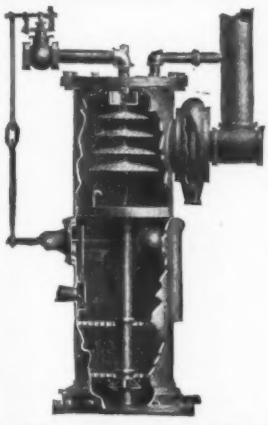
The

Patterson-Berryman Feed Water Heater

pays for itself repeatedly in each of several ways.
It saves the fuel that would be required to raise feed water to the boiling point.
It saves boiler repairs.
It prevents scale formation, etc.

Write!

Frank L. Patterson & Co.
28 Cortlandt Street, New York, U. S. A.



OUR TWINS

EITHER ONE WILL SAVE 15% of fuel and preserve the boiler.

Write for Prices, Etc.

The Sims Co.,
ERIE, PA.

Branch Office:
136 Liberty St., New York,
Tel., 539 Cortlandt.

The DETROIT Condensation Meter

(as shown)

ACCURATE
Guaranteed within 1% of accurate.

DURABLE
Construction is simple.

NOISELESS
The drum revolves.

Especially adapted for District Steam Heating Companies.

Sample on trial. Catalog No. 3 treats of District Steam Heating and our specialties.

The DETROIT Feed-Water Meter

The means of conducting a continuous boiler test without attention.

Guaranteed within 1% of accurate.

A check on the efficiency of your boilers, coal, etc.

Built in any size and for any requirement.

Catalog No. 2 explains the construction and operation of the meter.

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Do You Design or Install Condensing Machinery, or are You Thinking of Putting in Condensers, Air Pumps, Vacuum Pans, Multiple Effects, Centrifugal Pumps, Feed Water Heaters, Cooling Towers, Etc.?

If you are interested in these subjects, we would be pleased to add your name to our mailing list and if you have any case under present consideration, feel free to call upon our engineering department for aid, advice or suggestions. By reason of our extensive experience in work of this kind, we may be able to suggest lay-outs or arrangements that will improve results and reduce costs.

When writing ask for our new bulletin "I-P," describing our various lines.

WHEELER

CONDENSER & ENGINEERING CO.

CARTERET, NEW JERSEY.

New York, Cincinnati, Chicago, Denver, Boston, Pittsburg, St. Louis, San Francisco, Atlanta, Houston, St. Paul.

(Builders of Wheeler Surface, Wet and Barometric Condensers, Wheeler-Volz Combined Surface Condensers and Feed Water Heaters, Wheeler Feed Water Heaters, Barnard-Wheeler Cooling Towers, Wheeler-Edwards Air Pumps, Wheeler Centrifugal Pumps, Wheeler Rotative Dry Vacuum Pumps and Wheeler Multiple Effect and Evaporating Machinery). 4

The Deane Independent Condensing Apparatus shown here, is one of the condensers which are today condensing steam from several thousand engines in power houses of all kinds.

If thinking of installing a condensing apparatus, why not specify a Deane Condenser. Our installations give results and not trouble.

Vertical Fly-Wheel Condensers.

Vertical Direct Acting Condensers.

PRICES furnished upon application.

MANUFACTURED BY

The Deane Steam Pump Co.

HOLYOKE, MASSACHUSETTS, U. S. A.

Warerooms:

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PHILADELPHIA, 724 Arch Street
CHICAGO, 770 Old Colony Building
ST. LOUIS, 605 Chemical Building

GET RID OF SCALE BEFORE INSTEAD OF AFTER IT REACHES THE BOILER

Write for particulars.

The Eclipse Feed Water Heater & Purifier Co.
Oshkosh, Wisconsin.

Dean Bros. Steam Pump Works

Simple Plunger Pump

INDIANAPOLIS

Simple and Duplex Boiler Feeders. Jet and Surface Condensers. Power and Electric Pumps.

Alberger Condenser Co.

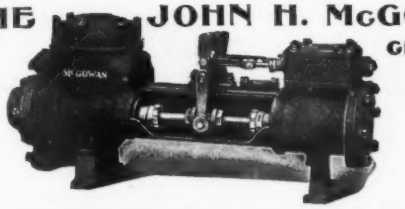
Condensers, Cooling Towers, Vacuum Pumps, Heaters

95 Liberty St. New York

Centrifugal, Volute, and Turbine Pumps

Alberger Pump Co.

THE JOHN H. McGOWAN CO.



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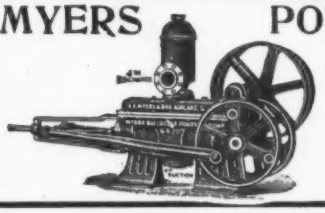
Builders of
PUMPING MACHINERY
Single Duplex and Fly-Wheel Types
Water Works Pumping Engines

MYERS POWER PUMPS



Adapted especially for gas engines, motor and belt powers, in harmony with present requirements.
Catalog sent on request.

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MORRIN CLIMAX BOILERS

They allow perfect utilization of every particle of heat and thus produce more steam per pound of coal than any other make.
Sizes from 50 to 1000 h. p. If you are interested in steam economy send for our booklet.

MORRIN CLIMAX BOILER WORKS, - - - BROOKLYN, N. Y., U. S. A.

THE BABCOCK & WILCOX COMPANY

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WATER TUBE STEAM BOILERS

STEAM SUPERHEATERS—MECHANICAL STOKERS

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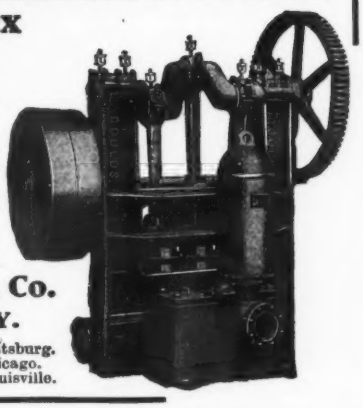
The Many Installations of GOULDS Efficient Triplex Power Pumps



For Municipal Water Works
Boiler Feeding
Hydraulic Elevators
Mine Pumping
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Have fully demonstrated their practicability and efficiency for these important services.

The Goulds Mfg. Co.
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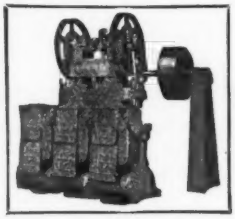
New York. Philadelphia. Pittsburg.
St. Louis. New Orleans. Chicago.
Los Angeles. San Francisco. Louisville.

Deming

Ask for Catalogue "G" and treatise "Feeding Boilers."



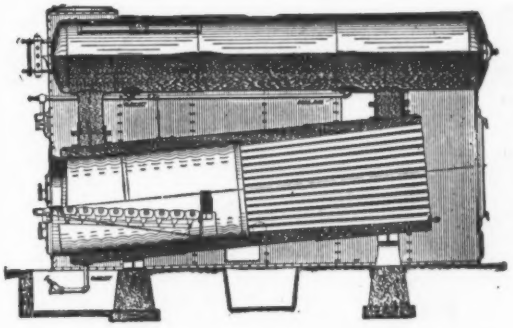
For any service. Power

For operation by any power. Pumps

The Deming Company
Agencies in Principal Cities
Salem, Ohio

Save Money by Buying a

ROBB-MUMFORD



Internally Fired Boiler

Low first cost—Saving in fuel—Durable, Safe—Built in all sizes from 60 to 250 horsepower.

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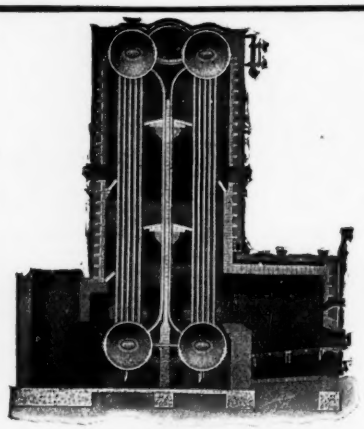
SOUTH FRAMINGHAM, MASS.

New York Office. 90 West Street. Boston Office, 170 Summer Street.
Built in Canada by Robb Engineering Co., Ltd., Amherst, N. S.



TYPE B

THE RUST
WATER TUBE
BOILER

SAFE, SIMPLE, DURABLE,
ECONOMICAL, ACCESSIBLE

Write for Report of Tests by William Kent.

THE RUST BOILER CO.,
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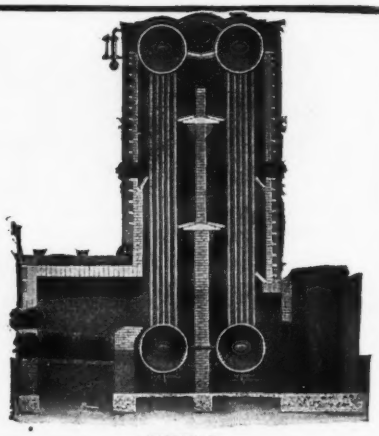
Branch Offices: New York, 50 Church Street; Birmingham, Alabama, First National Bank Building.



TYPE G

PARKER BOILER CO.
WATER TUBE BOILERS—SUPERHEATERS.
PHILADELPHIA, PENNA.
New York—Pittsburg—Chicago—Denver—San Francisco.

Foster Superheaters
Save from 10 to 40% fuel in engines and pumps.
POWER SPECIALTY CO.,
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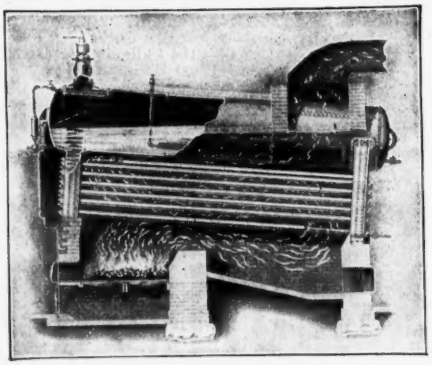
FRANKLIN WATER TUBE BOILER



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FRANKLIN BOILER WORKS CO.,
TROY, N. Y.
SALES OFFICE
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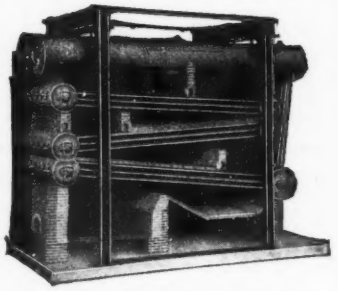
Several Large Combustion Chambers
with their lining of red hot fire tiles, extract every possible heat unit.

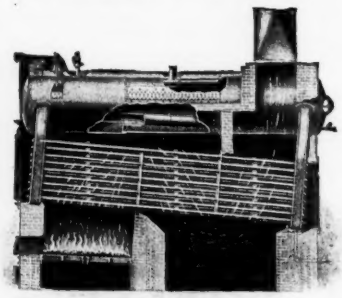
VOGT WATER TUBE BOILERS
consequently require considerably less fuel to generate more steam than boilers of other makes.

Circular?



HENRY VOGT MACHINE CO., Inc.
LOUISVILLE, KY.

Water Tube Boilers



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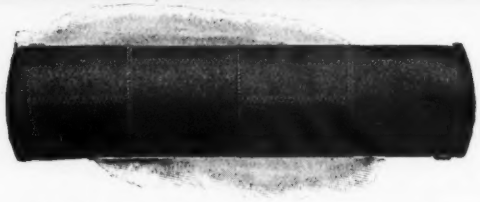
New York, Philadelphia, Chicago, San Francisco, Wilkesbarre and New Orleans.



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We are the largest and best manufacturers of storage and pressure tanks in the United States. The story is told. See Book No. 51. Send your specifications.

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Edge Moor Boilers
—WATER TUBE—
EDGE MOOR IRON CO., Edge Moor, Delaware

Inquire About 800 H. P. Units.

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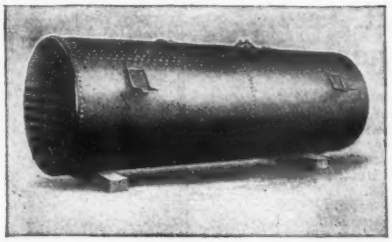

WICKES Horizontal Tubular Steam Boilers

HIGHEST GRADE

THE WICKES BOILER CO.

Also Manufacturers of the Wickes Vertical Water Tube Safety Steam Boilers

Main Office and Works, Saginaw, Mich.

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HEINE WATER TUBE BOILERS

AND SUPERHEATERS

All Flange Steel Construction

Send for { Boiler Logic and Superheater Logic

Heine Safety Boiler Co. 421 Olive St., St. Louis, Mo.

Not Necessary to Watch the Pressure

the unfailing automatic action of the

FISHER PUMP GOVERNOR

saves the engineer's time, prevents bursting mains, saves fuel and uses power in the most economical way.

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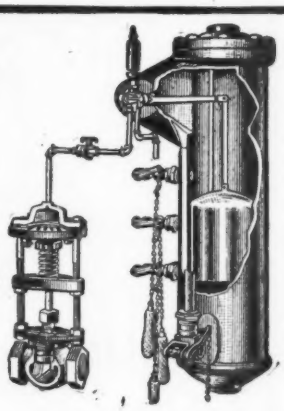
THE FISHER GOVERNOR CO.
MARSHALLTOWN, IOWA.

THE BERRY Safety Automatic Feed Water REGULATOR



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BERRY ENGINEERING COMPANY
Chester, Penn.

Canadian Office, Room 16, No. 17 St. John St., Montreal, Canada.

We're Going to Raise Your Salary

"Yes, young man, we find that the training you have applied to your work has been so beneficial to the Company that we are going to encourage your further efforts by raising your salary."

Such scenes as these are actually taking place every day. The man who gets the raise is the **trained** man—the expert—while the untrained man plods along at the same old wages. If **you** are poorly paid and have ambition, there is a practical and definite system by which you can obtain promotion—a system that last year brought over $20,000,000 in increased salaries to the men that adopted it.

You won't have to leave home; there'll be no interruption in your work; there's no age limit; you won't have to buy books; it makes no difference what you do or where you live; lack of capital is no barrier; it makes no difference how scant your spare time may be.

If you are ambitious, mark and mail this coupon **NOW** and find out the most practical way to raise your salary.

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Please explain without further obligation on my part, how I can qualify for a higher salary and advancement to the position before which I have marked X.

Electrical Engineer	Machine Designer	Sanitary Engineer
Elec.-Lighting Supt.	Mechanical Draft.	Architect
Elec.-Railway Supt.	Foreman Machinist	Architectural Draft.
Electrician	Foreman Toolmaker	Ad Writer
Telephone Engineer	Foreman Molder	Window Dresser
Civil Engineer	Foreman Blacksmith	Chemist
Bridge Engineer	Marine Engineer	Sheet-Metal Draft.
Mechanical Engineer	Hydraulic Engineer	Ornamental Design.
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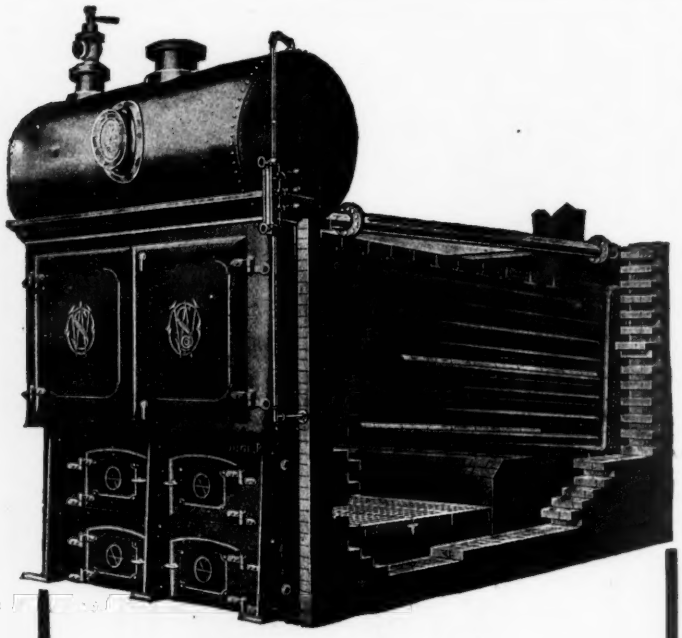

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in any power plant is the boiler system. If you appreciate that fact you will do well to investigate

Our Safety Water Tube Boiler

Built for any pressure from 125 to 300 pounds. Meets all the high duty requirements of modern triple and quadruple expansion and compound engines. Perfect circulation, remarkable economy, and freedom to expand and contract, are features.

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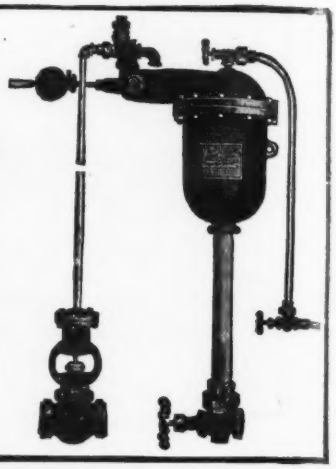
for Steam Boilers was the first in the field, and has the longest and best record of any of these devices. *Costs less to operate and maintain.* Constructed on a different and better principle than any other. Investigate it and the FULTON PUMP GOVERNOR, and send for latest catalog with list of users. A guarantee from a responsible firm with every machine.



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The overload capacity of **C-W** electric generators makes them popular with the engineer. In emergencies they do better than is expected of them. Bulletin 80M describes our D. C. machines.

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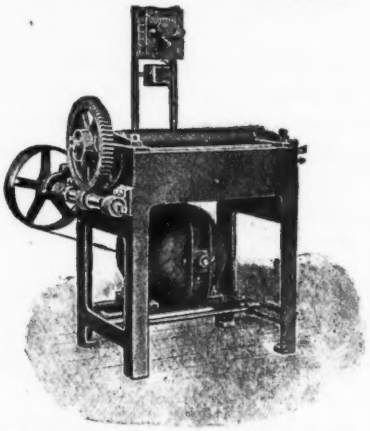

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Machines, Condensers, Tanks, Cans, Coolers, Piping, Boilers and Ammonia Fittings.

of all kinds. We employ over 1,250 men in the manufacture of Ice and Refrigerating Machinery exclusively. Catalogue sent upon request.

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GIVE CHEAP AND CONVENIENT POWER.

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The Foos system of Center line Counterbalancing is the only correct one.

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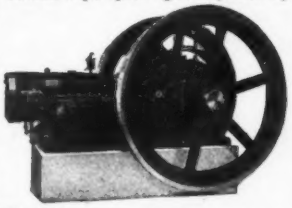

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THE CHEAPEST POWER IN THE WORLD

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require power applied to the work right where you want it—power that is convenient, quick, always

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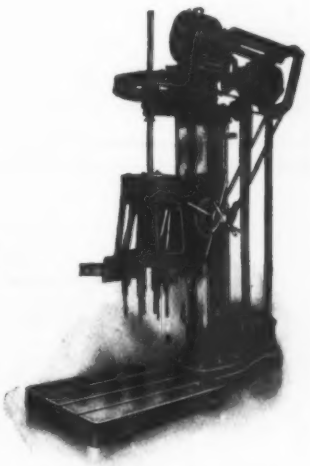
Fort Wayne Motors are ready now to prove their worth to you.

Tell us your drive.
We have the driver.



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Type EF Motor Driving Multiple Spindle Drill.

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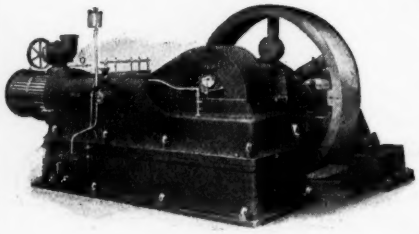

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Skinner Engines

CENTER CRANK
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SINGLE and FOUR VALVE

Skinner Engine Co.,
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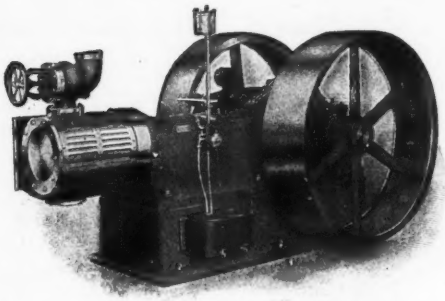

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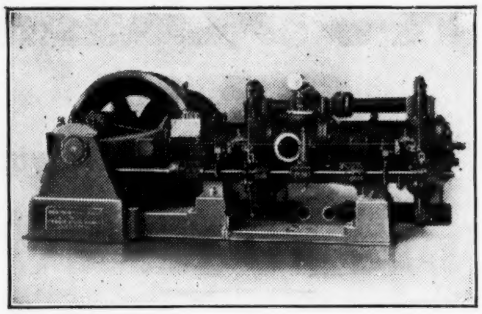

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Simple design, perfect construction, absolute governor control, fuel economy and generous weight to withstand continuous high pressure.

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is the Riverside Heavy Duty Gas Engine; the engine of highest mechanical efficiency. We can prove it! Made in 12 types and 72 sizes, ranging from 10 to 2500 H.P. Also a complete line of gas-driven air and gas compressors.

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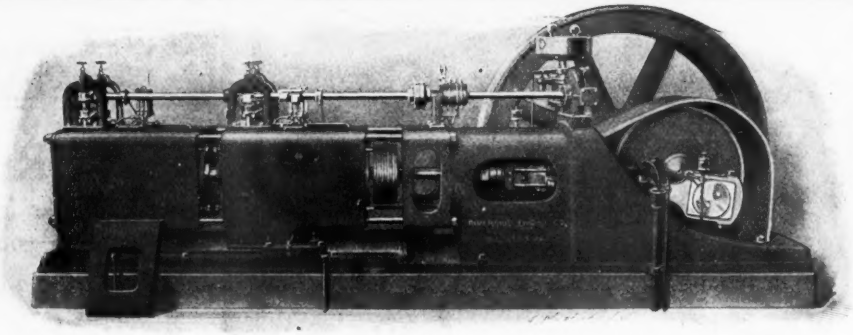

Riverside Heavy Duty Single Acting Tandem Gas Engine (Class C) showing quick method of exposing piston and rings.

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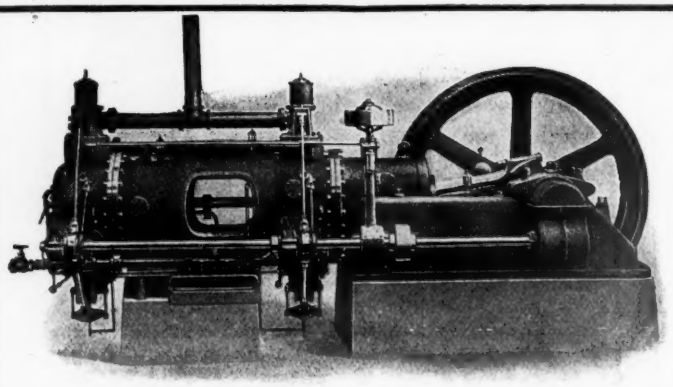

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Types up to 700 H. P.

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Economy and Reliability Have Been Demonstrated by Actual Service

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Manufacturers

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and experts to use them with the least possible delay will be sent to your plant immediately on receipt of your order. No need of dismantling your engine or shutting down even for a day. We'll fix it between sunset and sunrise. Write.

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"Useful Hints 'P'" sent to engineers upon request.

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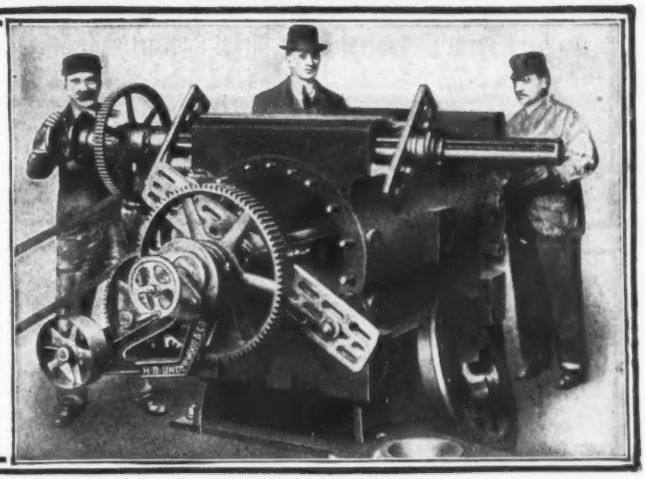

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BUILDERS OF HIGH CLASS

STEAM AND GAS ENGINES

HIGH IN DUTY, SUPERIOR IN REGULATION

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CORRESPOND WITH US BEFORE PURCHASING

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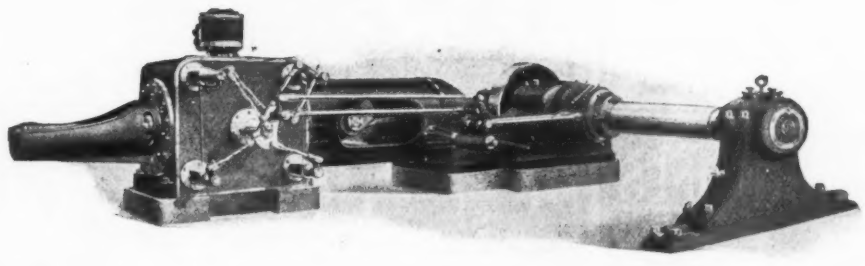
THE CLARK HEAVY DUTY CORLISS ENGINE



Valve travel never varies. No other Corliss engine has this advantage. Result perfect valve seats. Cuts off at all loads. As quick as the releasing gear. Heavy duty bed with bored guide. Main bearings half diameter of pistons. Length in proportion. Outboard bearing pedestal type. Adjustable in all directions. And self-oiling. Shaft swelled between bearings. Wheels above ten feet in diameter in halves. All whee's have split hubs. Our engines are unequaled for low steam consumption, perfect regulation, long life, nominal repairs, beauty of design. Perfect distribution of metal, high class material. Perfect workmanship

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Weiss Counter-Current Condenser.

We are sole licensees in the United States for the manufacture and sale of this Condenser, and will gladly send particulars to any one interested.

We guarantee any desired vacuum, using less cooling water and of higher temperature than other apparatus.

All contracts made upon positive statements as to relative volume of steam and water.

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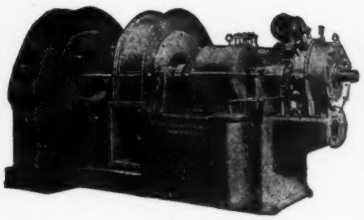

Steam Turbine Motors
Steam Turbine Dynamos
Steam Turbine Blowers
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Built only by
THE BALL ENGINE CO.
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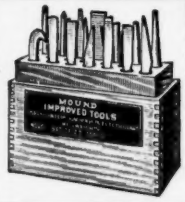

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No. 20 Set of 20 Tools . . . $4.00.

Book "Engineers' Chums" free. Address Dept. B

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AN ECONOMICAL AND DURABLE ROTARY ENGINE
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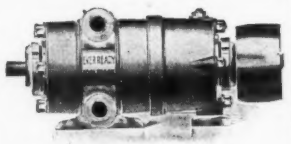

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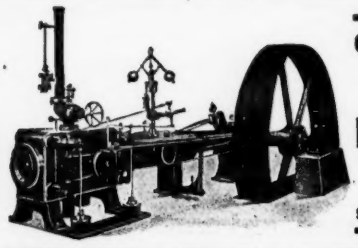

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Refrigerating and Ice Making Machinery

THE VILTER MFG. CO.
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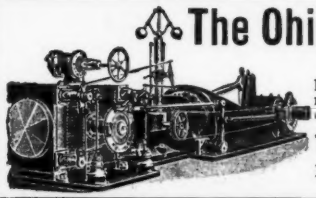

For hard work, heavy loads and high-speed, the Ohio shows close regulation and runs smoothly and quietly.

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CORLISS ENGINES
For Reliability and Economy.

Built by
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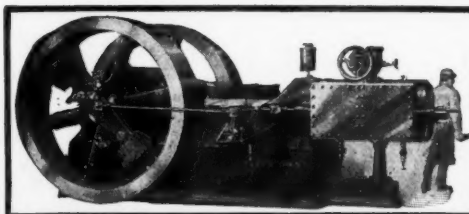

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for every power purpose. Ask for Catalog.

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A.H.ALBERGER COMPANY

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One 19-inch by 42-inch girder frame engine, right hand, 100 revolutions, rated at 280 h.p.; wheel 14-ft. diameter by 33-inch face.

The above are **new** engines.

One 14-ft. diameter by 28-inch face pulley, turned for belt. Hub bored 11-inches diameter. Wheel weighs 15,000 pounds.

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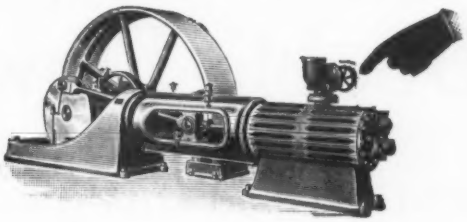

prove beyond question that

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give that lasting satisfaction which results only from a splendid design worked out with the best of materials and labor. Ask for our "one hour per year" guarantee.

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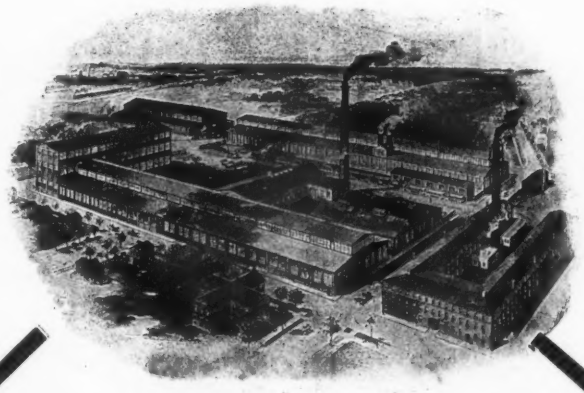

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We build engines for Rolling Mill, Railway, Lighting, and general Power Plant service.

Complete Steam Plant Engineering a specialty.

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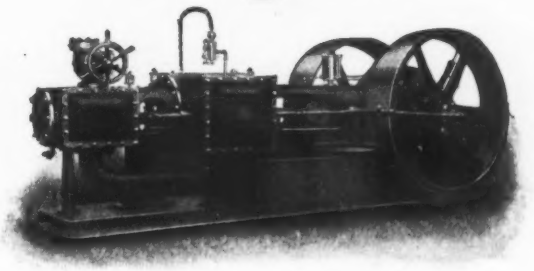
The McEwen Engine



The best Engine for Dynamo Driving

Built to stand rapid fluctuations of load. Not one revolution slower when fully loaded than when running light. Details *simple*. Valves *perfectly balanced*. Regulation *perfect*. A high speed engine for strenuous duty. Write !

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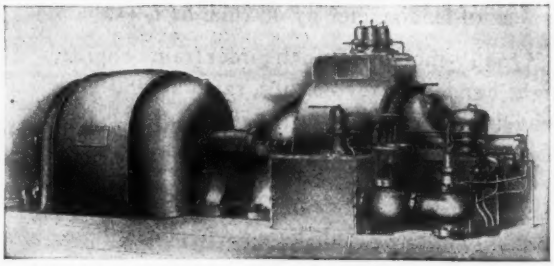
Double-Flow Steam Turbines

Made in Capacities From 7,500 to 20,000 H. P.

All the Good Qualities

of our single-flow turbines are retained in our double-flow type and they have, in addition, valuable features especially adapting them to the extra heavy duty for which they are intended.

They occupy less space.
The blading is reduced.
No balancing devices are required.
Cover can be raised without disturbing connections.



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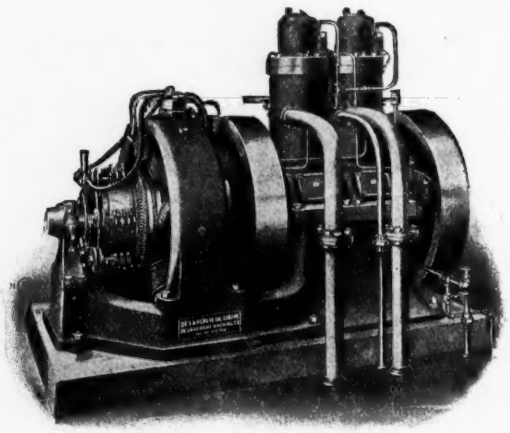

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OIL ENGINES

are cheaper, simpler. more compact than any other motive power. 8 H. P. hours per gallon of cheap oil.

5315 H.P. used by Baldwin Locomotive Works

The "De La Vergne" Vertical two-Cycle 4 to 25 H. P.
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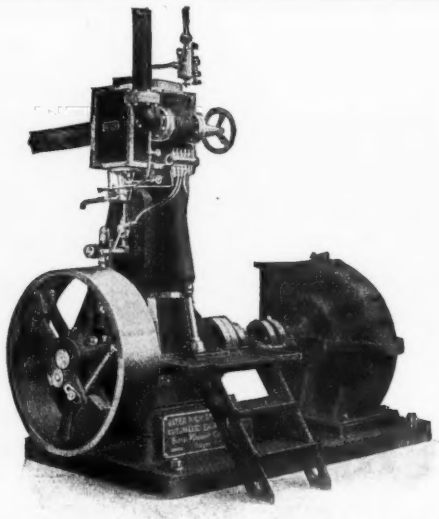

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WATER WORKS, IRRIGATION

and other places where it is desired to move a large volume of water at small expense.

CATALOG FOR THE ASKING.

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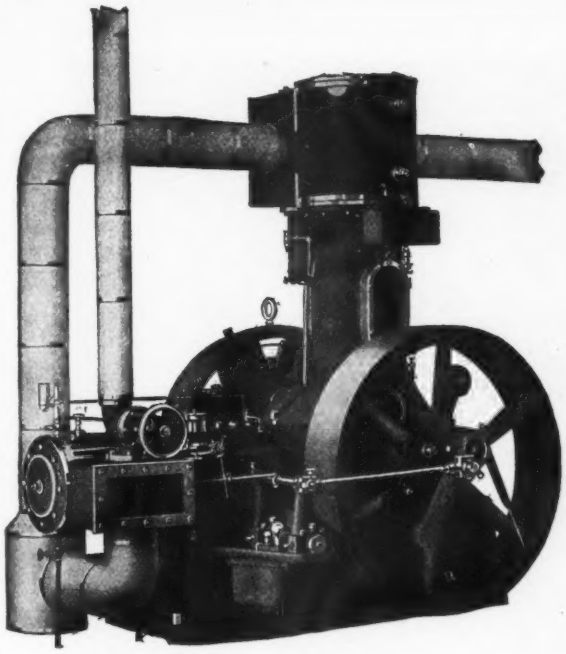

The American-Ball Angle Compound Engine

is built for those discriminating buyers who appreciate the difference between an engine running at high speed and a REAL high speed engine.

Our designers threshed out problems of steam economy, balancing, close governing, lubrication, etc., before most modern engines were put on the market and in these American-Ball Angle Compounds, our latest products, we have embodied a simplicity of operation, reliability, astonishingly small cost of maintenance and other refinements, which easily make them the best high speed engines of their power. That this estimate is not overdrawn, is evidenced by recent sales to the following representative steam users, all of whom are using one or more units of from 160 to 500 H. P. each.

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United Gas Improvement Co., Gloversville, N. Y.
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No. 7

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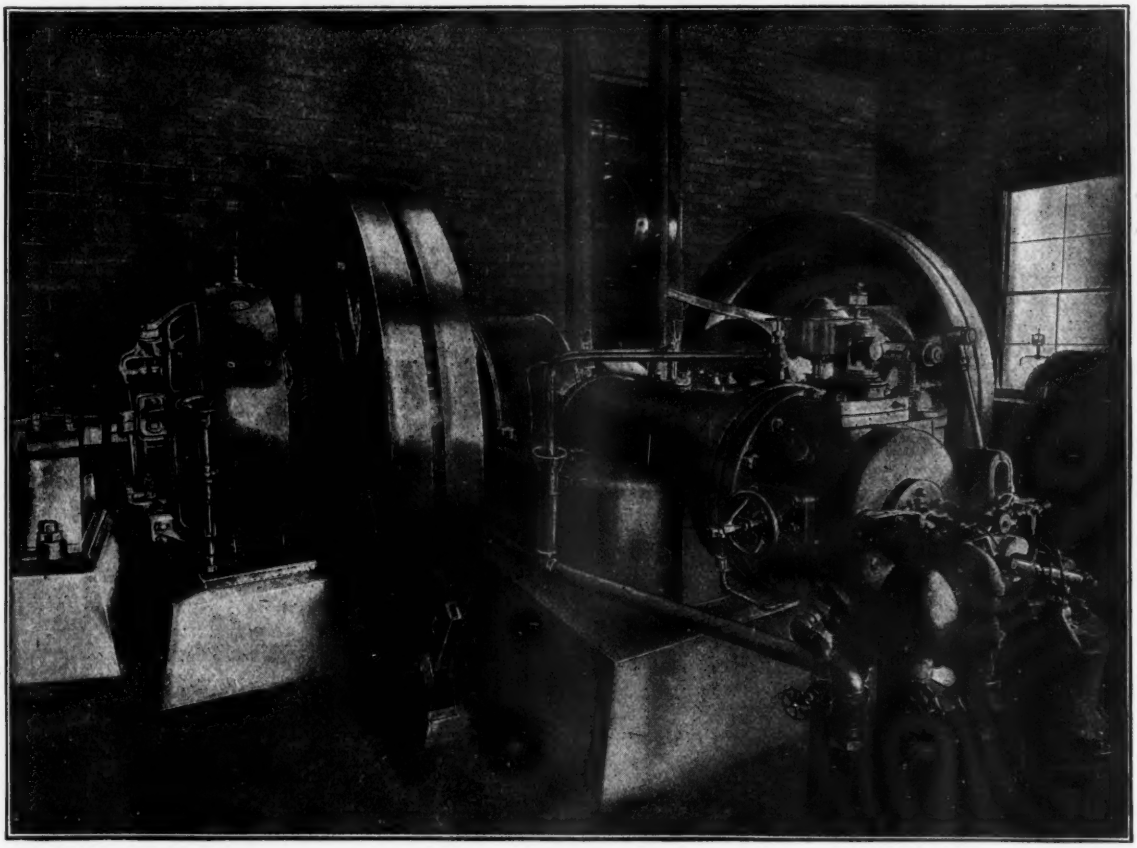

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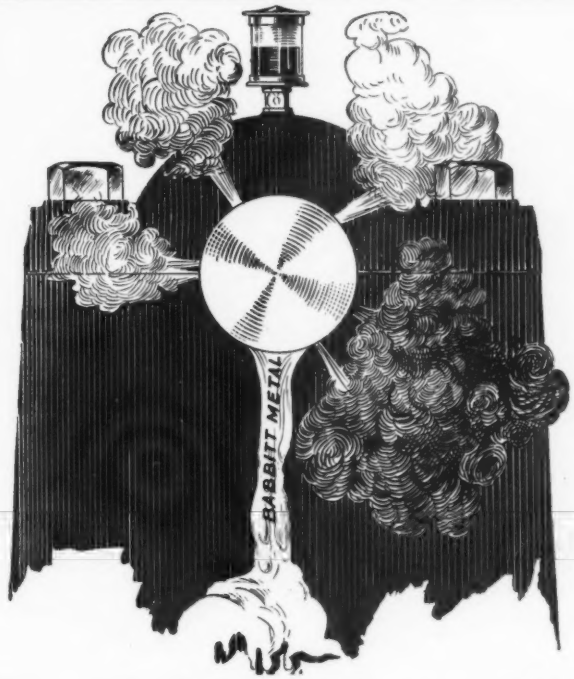

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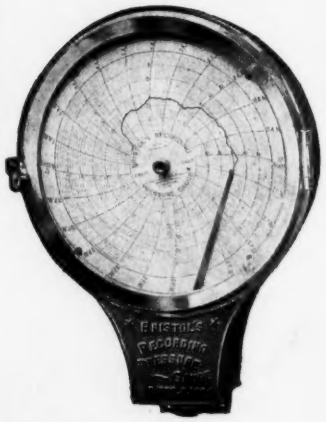

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